

# **Estimates of Commercial and Sport Harvest and Escapement of Coho Salmon Stocked into Northern Cook Inlet Streams, 1998**

by

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April 2001



## Symbols and Abbreviations

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Weights and measures (metric)		General		Mathematics, statistics, fisheries	
centimeter	cm	All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.	alternate hypothesis	H <sub>A</sub>
deciliter	dL	All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.	base of natural logarithm	e
gram	g	and	&	catch per unit effort	CPUE
hectare	ha	at	@	coefficient of variation	CV
kilogram	kg	Compass directions:		common test statistics	F, t, $\chi^2$ , etc.
kilometer	km			confidence interval	C.I.
liter	L			correlation coefficient	R (multiple)
meter	m	east	E	correlation coefficient	r (simple)
metric ton	mt	north	N	covariance	cov
milliliter	ml	south	S	degree (angular or temperature)	°
millimeter	mm	west	W	degrees of freedom	df
		Copyright	©	divided by	÷ or / (in equations)
		Corporate suffixes:		equals	=
		Company	Co.	expected value	E
		Corporation	Corp.	fork length	FL
		Incorporated	Inc.	greater than	>
		Limited	Ltd.	greater than or equal to	≥
		et alii (and other people)	et al.	harvest per unit effort	HPUE
		et cetera (and so forth)	etc.	less than	<
		exempli gratia (for example)	e.g.,	less than or equal to	≤
		id est (that is)	i.e.,	logarithm (natural)	ln
		latitude or longitude	lat. or long.	logarithm (base 10)	log
		monetary symbols (U.S.)	\$, ¢	logarithm (specify base)	log <sub>2</sub> , etc.
		months (tables and figures): first three letters	Jan,...,Dec	mid-eye-to-fork	MEF
		number (before a number)	# (e.g., #10)	minute (angular)	'
		pounds (after a number)	# (e.g., 10#)	multiplied by	x
		registered trademark	®	not significant	NS
		trademark	™	null hypothesis	H <sub>0</sub>
		United States (adjective)	U.S.	percent	%
		United States of America (noun)	USA	probability	P
		U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)	probability of a type I error (rejection of the null hypothesis when true)	α
				probability of a type II error (acceptance of the null hypothesis when false)	β
				second (angular)	"
				standard deviation	SD
				standard error	SE
				standard length	SL
				total length	TL
				variance	Var
<b>Weights and measures (English)</b>					
cubic feet per second	ft <sup>3</sup> /s				
foot	ft				
gallon	gal				
inch	in				
mile	mi				
ounce	oz				
pound	lb				
quart	qt				
yard	yd				
Spell out acre and ton.					
<b>Time and temperature</b>					
day	d				
degrees Celsius	°C				
degrees Fahrenheit	°F				
hour (spell out for 24-hour clock)	h				
minute	min				
second	s				
Spell out year, month, and week.					
<b>Physics and chemistry</b>					
all atomic symbols					
alternating current	AC				
ampere	A				
calorie	cal				
direct current	DC				
hertz	Hz				
horsepower	hp				
hydrogen ion activity	pH				
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

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COOK INLET STREAMS, 1998**

by

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## ABSTRACT

Juvenile coho salmon *Oncorhynchus kisutch* reared in hatcheries and released into several Northern Cook Inlet (NCI) freshwater systems in 1997 returned to Upper Cook Inlet (UCI) in 1998. Some fish in each release group were marked with an adipose finclip and a coded wire tag (CWT). Marked coho salmon were recovered in 1998 from selected UCI commercial fisheries to estimate harvest of hatchery-produced coho salmon.

In 1998 the UCI mixed-stock commercial fisheries harvested 160,644 coho salmon. The majority (85%) of coho salmon were harvested in the Central District drift gillnet fishery (83,337; 52%), the Northern District set gillnet fishery (34,359; 21%), and the Central District Upper Subdistrict (eastside) set gillnet fishery (18,662 12%). Sample effort focused on coho salmon harvested in these three fisheries. NCI hatchery-stocked coho salmon contributed an estimated 4,632 (SE = 223) fish to the Central District driftnet fishery; 339 (SE = 85) fish to the Central District eastside setnet fishery; and 3,757 (SE = 137) fish to the Northern District setnet fishery.

An escapement of 1,090 coho salmon into Ship Creek and 2,968 coho salmon into Campbell Creek exceeded the biological escapement goal of 200 coho salmon for each creek. Effort, harvest, and catch estimated from the Statewide Harvest Survey increased in 1998 relative to the 1988-1992 (prestocking) averages at Ship, Campbell, and Bird creeks, most likely due to the return of stocked coho salmon.

Key words: coho salmon, *Oncorhynchus kisutch*, commercial harvest, sport harvest, escapement, coded wire tag, Northern Cook Inlet, stocking, straying.

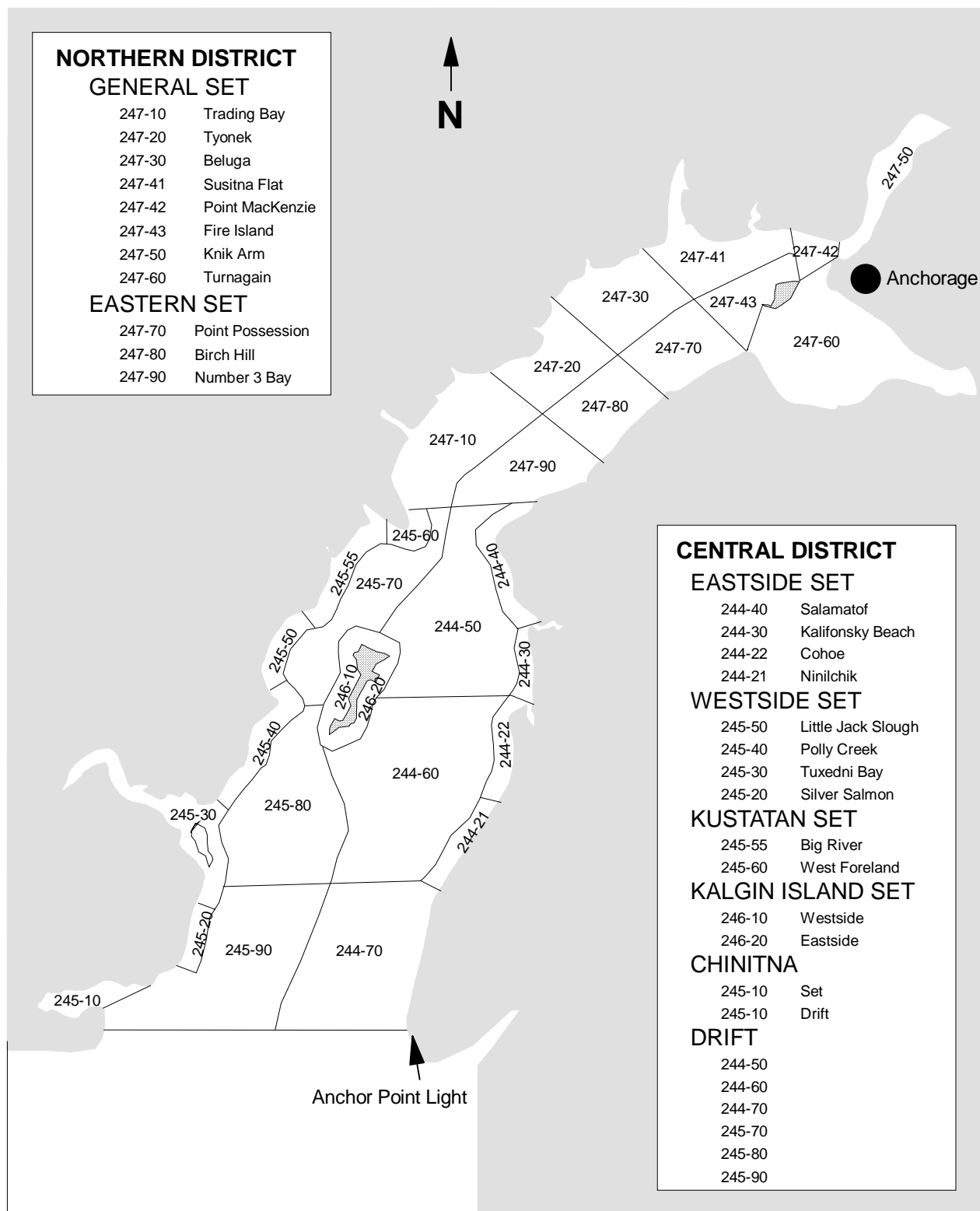
## INTRODUCTION

Upper Cook Inlet (UCI) includes all waters of Cook Inlet north of a line at the latitude of Anchor Point light (Figure 1). Coho salmon *Oncorhynchus kisutch* stocks are distributed throughout UCI and support large commercial and sport harvests. In 1998, approximately 32% of the total central region commercial harvest (ADF&G 1999) and 31% of the total statewide sport harvest (Howe et al. *In prep c*) of coho salmon occurred in UCI. The primary UCI coho salmon commercial fisheries are: (1) Central District drift gillnet, (2) Central District Upper Subdistrict (eastside) set gillnet, and (3) Northern District set gillnet fisheries (Figure 1). The most popular directed sport fisheries in UCI are Kenai River on the Kenai Peninsula, Susitna River drainage and Little Susitna River in Northern Cook Inlet, and Ship Creek in the Anchorage area.

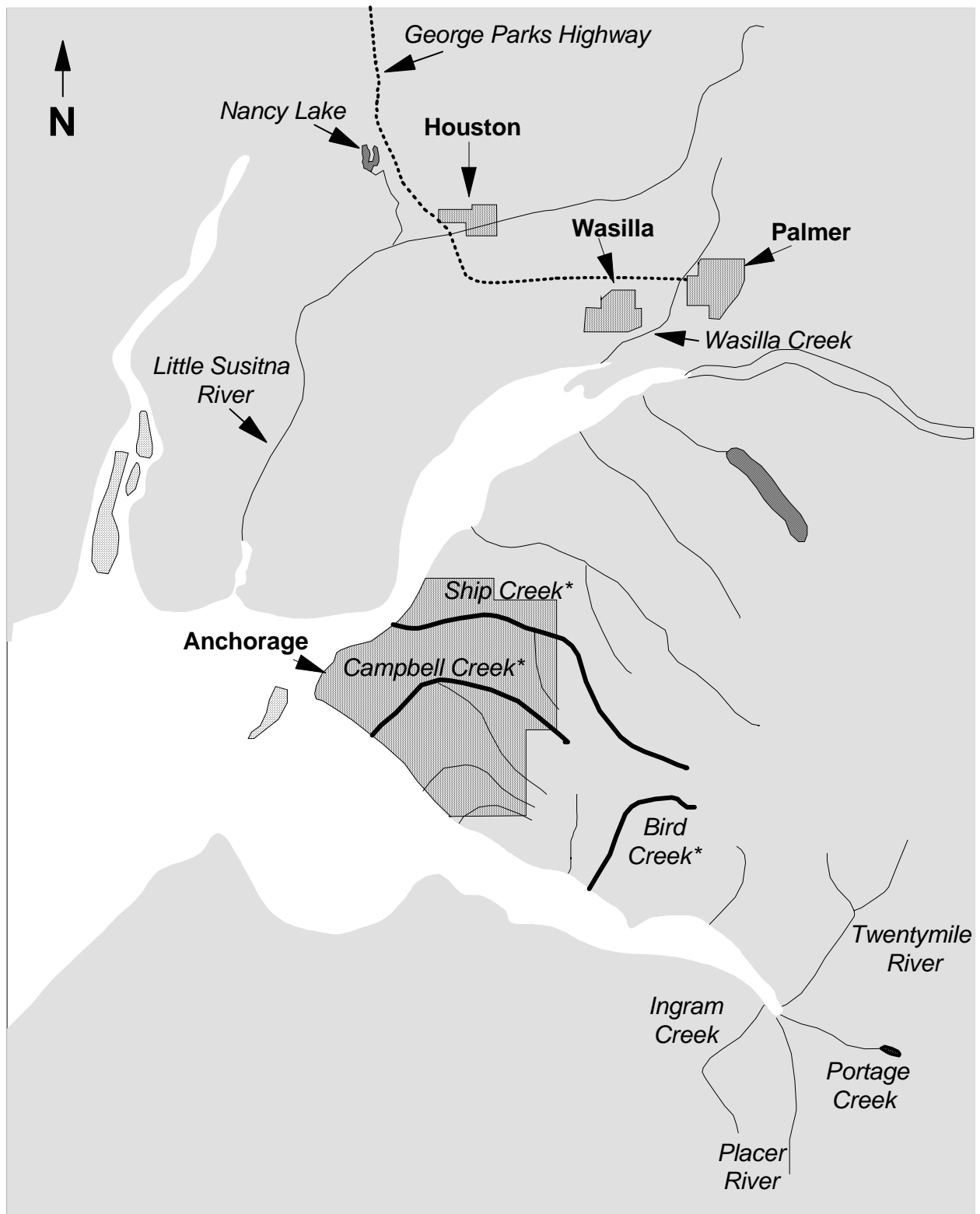
The Northern Cook Inlet (NCI) urban area extends from Ingram Creek in Turnagain Arm north to the Little Susitna River drainage (Figure 2). Recreational fishing effort in this

area increased from an average of about 214,400 angler-days from 1979-1988 to about 276,000 angler-days annually from 1989-1998 (Mills 1981a-1994, Howe et al. 1995 and 1996, *In prep a, b, and c*). Anglers fishing in NCI target five species of Pacific salmon *Oncorhynchus*, rainbow trout *O. mykiss*, Dolly Varden *Salvelinus malma*, Arctic char *S. alpinus*, Arctic grayling *Thymallus arcticus*, and northern pike *Esox lucius*. Sport fisheries for these species are supported by a combination of wild and hatchery-produced stocks.

As the NCI human population grows, the demand for sport fishing opportunities increases. Hatchery-produced stocks play an important role in supporting these growing sport fisheries as wild stocks become fully utilized. A coho salmon smolt stocking program was initiated in 1992 to increase recreational sport fishing opportunities in the NCI urban area, specifically in Bird, Campbell, and Ship creeks. To succeed, the stocking program must be cost-effective, have minimal impact on wild stocks and/or other



**Figure 1.-Upper Cook Inlet commercial salmon fishing districts and statistical areas.**



**Figure 2.-Northern Cook Inlet urban area. Streams stocked with coho salmon in 1997 are starred.**

fisheries, and maintain historic levels of spawning escapements in stocked streams.

The goal of the program is to create or enhance terminal sport fisheries in selected NCI urban area streams and attract additional recreational fishing participation. The program is targeted to increase recreational angler effort by 25,000 angler-days and harvest by 10,000 coho salmon relative to the 5-year prestocking mean levels among all stocked streams. The Statewide Harvest Survey (SWHS) is used to evaluate increases in angler effort (for all species combined) and coho salmon harvest. In 1997 a portion of the smolt released into each stream was marked with a coded wire tag (CWT) and an adipose finclip (Table 1).

Prior to the start of this program in 1992, there was no quantifiable information of stock composition from the mixed-stock commercial harvests, and virtually no information on the magnitude of inriver runs or spawning escapements. To provide information needed to manage these fisheries, an assessment program was initiated in 1991 to evaluate coho salmon stocks in UCI (Meyer et al. *Unpublished*). This program was designed to estimate harvest of selected wild and hatchery-reared coho salmon stocks in major UCI commercial fisheries and to evaluate the success of the coho salmon hatchery stocking programs in NCI. The overall program consists of three distinct but interrelated components: (1) estimation of commercial and inriver sport harvests, and escapement of coho salmon stocked in NCI streams; (2) marking of wild stock juvenile coho salmon, inriver recovery of marked adults, and estimation of UCI commercial harvests of coho salmon from the Kenai River; and (3) production, marking, and release of coho salmon smolt by the hatcheries.

This report focuses on the first component above and primarily on results of coho salmon stocked in 1997 that returned to UCI in 1998. The remaining two program components are reported elsewhere (Carlson and Hasbrouck 1993, 1996, 1997, 1998; Carlson 2000; Peltz and Starkey 1993; Peltz and Hansen 1994; Starkey et al. 1995-1997, 1999). In 1998 the NCI coho salmon hatchery-stocking assessment program was in its sixth year. Results from previous years can be found in Hoffmann and Hasbrouck (1994), Stratton et al. (1996), and Cyr et al. (1997-1999).

## OBJECTIVES

Objectives for the 1998 NCI coho salmon assessment fall into two categories: commercial harvest, and escapement.

Commercial harvest objectives were to:

1. Estimate harvest of hatchery-produced coho salmon stocked into NCI urban streams in: the Northern District setnet fishery, the Central District Upper Subdistrict (eastside) setnet fishery, and the Central District driftnet fishery.

Escapement objectives were to:

1. Estimate the hatchery contribution to the inriver returns at Campbell and Ship creeks for both the sport harvest and spawning escapement.
2. Enumerate coho salmon spawning escapement through a weir at Ship Creek. Index coho salmon spawning escapements in Bird and Campbell creeks using foot surveys, and selected Twentymile and Placer river drainages and Portage Creek tributaries using a combination of foot and aerial surveys.

**Table 1.-Summary of coded wire tagging data by release site for coho salmon smolt reared at Fort Richardson hatchery and stocked in Northern Cook Inlet streams, 1997.**

	Campbell Creek	Ship Creek	Bird Creek	Bird Creek	Total
Raceway	E1	E2	E3	E4	
Tag Codes	31-25-62	31-25-63	31-26-01	31-26-02	
Total marked and tagged	46,183	46,168	46,078	46,077	184,506
Mortalities	343	243	177	241	1,004
Marked fish released	45,840	45,925	45,901	45,836	183,502
Tag retention sample size	774	779	784	777	3,114
Tag retention at release	98.8%	99.6%	99.1%	99.2%	99.2%
Tag retention variance	1.53E-05	5.12E-06	1.14E-05	1.02E-05	4.20E-05
Tagged fish released	45,290	45,741	45,488	45,469	181,988
Tagged fish variance	32,229	10,800	23,999	21,486	88,514
Total fish released into creek <sup>a</sup>	71,519	232,066	294,565		598,150
Theta <sup>b</sup>	0.6333	0.1971	0.3088		0.3220
Proportion of fish released marked <sup>b</sup>	0.6409	0.1979	0.3114		0.3068
Percent tagged	32.8%	30.0%	33.6%		32.5%
Tagging dates	10/28/96 11/1/96	11/18/96 11/22/96	11/12/96 11/15/96	11/4/96 11/8/96	
Date of tag retention check	5/21/97	5/20/97	5/20/97	5/19/97	
Days elapsed <sup>c</sup>	201	179	186	192	

Source: Starkey et al. 1999.

<sup>a</sup> From hatchery inventory or physical count.

<sup>b</sup> Calculated from total fish released into each creek.

<sup>c</sup> Number of days between last tagging date and tag retention check date.

## **METHODS**

### **STUDY DESIGN**

This project was designed to estimate the harvest of hatchery-produced coho salmon stocked into NCI streams in the UCI mixed-stock commercial fishery, and to estimate the total run of stocked coho salmon to Bird, Campbell, and Ship creeks.

Coho salmon smolt were marked by inserting a CWT into their snout and removing their adipose fin. Marked smolt were mixed and released with unmarked smolt into each stream. A catch sampling program of adult coho salmon in the commercial harvest was conducted in 1998 to recover marked fish. Heads were collected from coho salmon missing the adipose fin and sent to the Alaska Department of Fish and Game (ADF&G) Coded Wire Tag Laboratory (Tag Lab) in Juneau. The Tag Lab determined if a tag was present and decoded recovered tags to determine year and stream of release. Catch sampling data were used to estimate harvest of marked cohorts and to calculate final estimates of harvest and their variances. Survival of hatchery-reared coho salmon from smolt to adult was also estimated.

### **DATA COLLECTION**

#### **Stocking and Marking**

Coho salmon from the Little Susitna River were used as brood stock for 1997 hatchery releases into Bird, Campbell, and Ship creeks. Nancy Lake is the brood stock collection site for Little Susitna River coho salmon and drains into Little Susitna River via Nancy Lake Creek. Gametes collected in 1995 from coho salmon in Nancy Lake were fertilized, then incubated, and the resultant fry reared at ADF&G's Fort Richardson Hatchery. The subsequent smolt were stocked in 1997 (Starkey et al. 1999) and returned as adults in 1998.

A portion of smolt from each release cohort was marked with an adipose finclip and a uniquely numbered CWT inserted in their snout. The tagging goal of 40,000 smolt per release stream was exceeded for all releases in 1997 (Table 1). The cohorts recovered in 1998 were primarily from 1997 releases which ranged from approximately 72,000 smolt released into Campbell Creek to approximately 295,000 smolt released into Bird Creek (Table 1). Details of the rearing, marking, and release of hatchery-stocked coho salmon are discussed in detail by Starkey et al. (1999).

#### **Commercial Harvest Sampling**

Sampling of the UCI commercial coho salmon harvest was conducted from 29 June-11 September, with the majority of sampling occurring mid-July through late August 1998. Coho salmon were sampled on sorting lines at processors, at buying stations, or onboard tenders. All regular commercial fishing periods (7:00 a.m. to 7:00 p.m., Mondays and Fridays) that occurred in the three fisheries of interest were sampled. Additional Central District fishing periods (as allowed through emergency order) were sampled as time and budget allowed.

Coho salmon delivered to processors, buying stations, or tenders were counted and examined for the absence of the adipose fin. As many fish as possible were examined from deliveries during the sampling shift. All coho salmon observed with a missing adipose fin were retrieved, the head removed, and a uniquely numbered cinch strap affixed to the head. Each head was placed in an individual clear plastic bag with the cinch strap number visible. Collected data included: date of harvest, date of sampling, processor, delivery location, name of tender or buying station, statistical area, number of coho salmon examined, number of coho salmon missing the adipose fin, number of heads collected

from coho salmon missing the adipose fin, and the cinch strap number of each head collected. All coho salmon heads with cinch straps were returned to ADF&G offices in Soldotna or Anchorage. The heads were frozen and shipped weekly to the Tag Lab for tag removal and decoding. After each commercial fishing period, the preliminary commercial harvest of coho salmon in UCI by statistical area was obtained from Commercial Fisheries Division (CFD) staff in Soldotna. Final commercial harvest data by statistical area and date were obtained on 29 December 1998.

In general, totes sampled from setnet harvested coho salmon were of fish harvested in a single statistical area. Thus, the total harvest and catch sample data could be summarized by statistical area. Totes of coho salmon sampled from the Central District driftnet fishery were a mixture of fish harvested in different statistical areas. Thus, harvest and catch sample data from the Central District driftnet fishery were combined for statistical areas 244-50, 244-60, 244-70, 245-70, 245-80, and 245-90.

### **Northern District**

The Northern District is subdivided into 11 statistical areas (Figure 1). By regulation, commercial fishing periods occur between 7:00 a.m. and 7:00 p.m. on Mondays and Fridays from 25 June (except when 25 June falls within a closed weekly period, then the season will open the next weekly period) until closed by emergency order (5 AAC 21.320 *Weekly Fishing Periods*). Additional fishing periods are allowed and/or regularly scheduled periods may be closed by emergency order; however, no additional fishing periods may be allowed after 15 August (5 AAC 21.363 *Upper Cook Inlet Salmon Management Plan*). Only set gillnet gear is allowed in Northern District waters (5 AAC 21.330 *Gear*). Statistical area 247-50

is only opened through emergency order (5 AAC 21.364 *Fish Creek Sockeye Salmon Management Plan*) and statistical area 247-60 is closed to commercial fishing (5 AAC 21.350 *Closed Waters*).

Harvest from the Northern District was sampled in Anchorage, Seward, and Nikiski from 13 July-11 September 1998. Coho salmon processed in the Anchorage area were composed entirely of fish harvested in Northern District statistical areas. Three technicians and one college intern in Anchorage sampled commercial harvests primarily at two shorebased processors, North Alaska Fisheries and Sahalee of Alaska. Some sampling also occurred at Alaska Smoked Salmon International, Alaska Gourmet Seafoods, and 10<sup>th</sup>&M Seafoods. Setnet harvests from statistical areas 247-70, 247-80, and 247-90, purchased by Cook Inlet Processors in Nikiski, were sampled regularly by personnel from Soldotna. Most coho salmon harvested from statistical areas 247-10, 247-20, and 247-30 were sampled at Icicle Seafoods in Seward and at Deep Creek Custom Packing Inc. in Ninilchik by Soldotna-based technicians. We needed to examine 35% of the harvest of each Northern District statistical area to achieve the desired accuracy and precision of the estimated harvest of hatchery-reared coho salmon. The project biologist and/or technicians contacted processors throughout the season to coordinate sampling logistics and to ensure that all fish possible were examined.

### **Central District**

The Central District driftnet fleet operates in seven statistical areas and the setnet fishery occurs in 13 statistical areas (Figure 1). Coho salmon harvested by driftnet were sampled from six statistical areas (244-50, 244-60, 244-70, 245-70, 245-80, and 245-90) and those harvested by setnet were sampled from four statistical areas (244-21, 244-22, 244-30,

and 244-40) composing the Upper Subdistrict (eastside) setnet fishery. We needed to examine 25% of the Central District driftnet harvest and 15% of the coho salmon harvested from each Central District eastside setnet statistical area to achieve the desired accuracy and precision of our estimates of commercial harvest.

Commercial fishing periods for both the driftnet and eastside setnet fisheries occur between 7:00 a.m. and 7:00 p.m. on Mondays and Fridays (5 AAC 21.320 *Weekly Fishing Periods*). Dates of the driftnet fishery are restricted to 25 June (except when 25 June falls within a closed weekly period, then the season will open the next weekly period) through 9 August (5 AAC 21.310). The *Upper Cook Inlet Salmon Management Plan* (5 AAC 21.363) restricts the dates of the setnet fishery from 1 July through 15 August. Additional fishing periods are allowed by emergency order as are restrictions to regularly scheduled periods. Several management plans affect time and area openings and closures of both fisheries (5 AAC 21.358 *Northern District Coho Salmon Management Plan*; 5 AAC 21.359 *Kenai River Late Run Chinook Salmon Management Plan*; 5 AAC 21.360 *Kenai River Late Run Sockeye Salmon Management Plan*; 5 AAC 21.361 *Russian River Sockeye Salmon Management Plan*; 5 AAC 21.363 *Upper Cook Inlet Salmon Management Plan*; and 5 AAC 21.365 *Kasilof River Sockeye Salmon Special Harvest Area Management Plan*).

The Central District driftnet harvest was sampled by six technicians from 29 June-7 August 1998. The harvest in the Central District eastside setnet fishery was sampled by four technicians from 6 July-10 August 1998. Most coho salmon harvested from these fisheries as well as some coho salmon harvested by Northern District setnet fisheries were processed at facilities on the Kenai

Peninsula. Commercial catch sampling of these coho salmon harvests was conducted under the supervision of CFD biologists in Soldotna. Sampling of the driftnet harvest occurred at Carlson Seafoods, Cook Inlet Processing, Dragnet Fisheries Co. Inc., Icicle Seafoods Inc., Inlet Salmon, Pacific Star Seafoods Inc., R & J Seafoods, Royal Pacific Fisheries Inc., Salamatof Seafoods Inc., Seasonal Seafoods, Snug Harbor Seafoods Inc., Trans-Aqua International Inc., and Wards Cove Packing Co. The Central District eastside setnet harvest was sampled at buying stations of major fish processors. These processors included: Alaska Salmon Purchasers, Cook Inlet Processing, Deep Creek Custom Packing Inc., Dragnet Fisheries Co. Inc., Fishhawk Fisheries Of Alaska Inc., Icicle Seafoods Inc., Inlet Salmon, Pacific Star Seafoods Inc., R & J Seafoods, Royal Pacific Fisheries Inc., Salamatof Seafoods Inc., Snug Harbor Seafoods Inc., Trans-Aqua International Inc., and Wards Cove Packing Co.

### **Escapement**

A fish pass with a livebox, hereafter called a weir, was used to enumerate the coho salmon escapement into Ship Creek. The total coho salmon count (less fish collected for future brood stock requirements) was used as the final tally. Returning adult coho salmon were examined for the absence of an adipose fin during brood stock collection. The total number of coho salmon examined and the number of fish missing the adipose fin were recorded.

A single foot survey conducted during peak spawning was used to index coho salmon escapements in both Bird and Campbell creeks. Coho salmon in the Campbell Creek escapement were captured using a beach seine and examined for the absence of an adipose fin 1 day each week from 4 September-25 September 1998. Seining occurred upstream of Lake Otis Parkway. Captured

fish were marked with a caudal hole punch to prevent double sampling.

Multiple foot (conducted by U.S. Forest Service personnel) and aerial surveys were conducted to index wild-stock coho salmon escapements in selected Twentymile and Placer river drainages and selected Portage Creek tributaries. Peak coho salmon counts were used as the final tally.

## DATA ANALYSIS

### Estimating Commercial Harvest of Stocked Coho Salmon

Estimating the commercial harvest of a cohort required determining the proportion of fish marked with a CWT and adipose finclip. The proportion of tagged coho salmon stocked at each location and tag retention was assumed known prior to release (Starkey et al. 1999). Based on inriver tag recoveries from adult coho salmon in previous years (Hoffmann and Hasbrouck 1994; Stratton et al. 1996; Cyr et al. 1997, 1998) we assumed tag loss after release was insignificant in 1998.

Harvest of a single marked cohort (release group) of fish in a stratum was estimated by (Bernard and Clark 1996):

$$\hat{r}_{ij} = N_i \theta_j^{-1} \left( \frac{m_{ij}}{\lambda_i n_i} \right), \quad (1)$$

where:

- $N_i$  = total number of fish harvested in stratum  $i$ ,
- $\theta_j$  = proportion of cohort  $j$  marked and released with a coded wire tag,
- $m_{ij}$  = number of decoded coded wire tags from cohort  $j$  in stratum  $i$ ,
- $n_i$  = number of fish in stratum  $i$  sampled for a missing adipose fin,

$\lambda_i = \frac{t_i' a_i'}{t_i a_i}$ , which is the decoding rate of

coded wire tags from marked fish sampled in stratum  $i$ ,

$a_i$  = number of fish sampled in stratum  $i$  missing their adipose fin,

$a_i'$  = number of heads from  $a_i$  that arrived at the Tag Lab,

$t_i$  = number of heads from  $a_i'$  with coded wire tags detected, and

$t_i'$  = number of tags from  $t_i$  that were decoded.

This estimator is statistically unbiased when sampling is from a simple random or pseudo-random process (Bernard and Clark 1996).

When the harvest ( $N_i$ ) and the proportion marked ( $\theta_j$ ) are known without error the large-sample approximation of an unbiased estimate of the variance is:

$$\hat{V}(\hat{r}_{ij}) = \frac{\hat{r}_{ij}}{\lambda_i \phi_i \theta_j} (1 - \lambda_i \phi_i \theta_j), \quad (2)$$

where:

$$\phi_i = \frac{n_i}{N_i}.$$

Total harvest from the fish ticket database is assumed known and measured without error. The values of  $\theta_j$  at the time of release (Starkey et al. 1999) were used and treated as known values measured without error for all 1997 releases.

Harvest of each cohort was stratified by date and statistical area for each sampled fishery. Statistical area was unknown when catch sampling the Central District driftnet fishery so harvest of this fishery was stratified only by date. The total harvest of a cohort in a fishery was estimated by summing the estimates among the strata. Variance of the

total estimate was also calculated by summing the variances of the strata estimates since strata were assumed independent and there were no additional covariance terms.

In 1998 approximately 75% of the sampled catch from Northern District statistical areas 247-10, 247-20, and 247-30, and about 21% of the sampled catch from Northern District statistical areas 247-70, 247-80, and 247-90 contained a mixture of coho salmon harvested from more than one statistical area. Nearly all coho salmon harvested from statistical areas 247-41, 247-42, and 247-43 were sampled throughout the season without being combined with fish harvested from other statistical areas. Sample data and harvest from all Northern District statistical areas except 247-43 were combined into three larger geographic areas: westside (247-10, 247-20, and 247-30); eastside (247-70, 247-80, and 247-90); and Susitna Flat/Point MacKenzie (247-41 and 247-42). Analyses of data collected in previous years indicated that combining catch sample and harvest data into these larger areas did not bias estimates of harvest of hatchery-reared coho salmon (Hoffmann and Hasbrouck 1994, Stratton et al. 1996, Cyr et al. 1997).

### **Estimating Sport Harvest and Escapement of Stocked Coho Salmon**

The harvest of hatchery-produced coho salmon by the sport fisheries in Campbell and Ship creeks was estimated using SWHS estimates of total sport harvest, the proportion of fish marked with an adipose finclip at time of release, and recovery data collected from returning adults during beach seining (Campbell Creek) and brood stock collection (Ship Creek). No heads were collected from coho salmon missing the adipose fin in Campbell Creek and all finclipped fish observed were assumed to be from hatchery stockings into Campbell Creek. Heads collected from coho salmon missing the

adipose fin during Ship Creek egg takes were sent to the Tag Lab in Juneau for decoding. Based on recovery data in previous years (Hoffmann and Hasbrouck 1994, Stratton et al. 1996, and Cyr et al. 1997, 1998) the straying rate from the stream of origin was assumed insignificant. In 1998 field observations indicated that sport anglers were not selective in harvesting coho salmon in these streams, so it was assumed that the marked proportion of fish observed in the escapement was the same as that in the respective sport harvest. Contribution of hatchery-produced coho salmon to the sport harvest of each creek was estimated by:

$$\hat{r}_k = \hat{N}_k \psi_j^{-1} \left( \frac{m_{kj}}{n_k} \right), \quad (3)$$

$$\hat{V}(\hat{r}_k) = \hat{r}_k^2 \left[ \left( \frac{1 - \hat{\phi}_k \psi_j}{m_{kj}} \right) + G(\hat{N}_k) - \left( \frac{1 - \hat{\phi}_k \psi_j}{m_{kj}} \right) G(\hat{N}_k) \right] \quad (4)$$

where:

$\hat{N}_k$  = SWHS estimates of coho salmon sport harvest for stream k,

$m_{kj}$  = number of fish missing the adipose fin observed from cohort j in stream k,

$n_k$  = total number of coho salmon sampled in stream k,

$\psi_j^{-1}$  = proportion of cohort j marked with an adipose finclip at time of release,

$\hat{\phi}_k = \frac{n_k}{\hat{N}_k}$ , and

$G(\hat{N}_k)$  = coefficient of variation squared of total sport harvest in stream k from SWHS.

The contribution of hatchery-produced coho salmon to the spawning escapements in Campbell and Ship creeks was estimated

using equations (3) and (4), where  $\hat{N}_k$  = spawning escapement. The escapements from the foot survey (Campbell Creek) and weir count (Ship Creek) were measured without error; therefore, the coefficient of variation  $G(\hat{N}_k)$  was zero.

All coho salmon in both the sport harvest and indexed escapement at Bird Creek were assumed to be from hatchery releases because no significant numbers of coho salmon were observed in Bird Creek prior to the initial stocking in 1992.

## RESULTS

### COMMERCIAL HARVEST OF STOCKED COHO SALMON

A total of 160,644 coho salmon were harvested in UCI mixed-stock fisheries in 1998 (Table 2). A combined total of 135,810 coho salmon were harvested in the sampled fisheries (Table 3). Harvest sampling did not occur over the entire fishing season; however, only 2% of the overall UCI coho salmon harvest in the selected fisheries occurred on days not sampled. Harvest on days not sampled was combined with the nearest day the harvest was sampled to estimate harvest of marked cohorts for the entire season.

Technicians examined 40% of the total harvest for sampled UCI fisheries and 4% of the fish examined had a missing adipose fin. In the Northern District, 65% of the coho salmon harvested were examined for a missing adipose fin. In the Central District driftnet and eastside setnet fisheries, 32% of the coho salmon harvested in each respective fishery were examined. It was possible to sample a greater proportion of the Northern District harvest than the Central District harvest because fewer processors purchased fish, there were fewer fishing periods, and all fishing periods were scheduled openings

rather than a combination of scheduled and emergency order openings.

Z-tests to determine if combining data from statistical areas in the Northern District introduced significant bias in estimates could not be performed for the majority of sample data because, for the majority of sample data from the Northern District, there were too few samples collected from unmixed loads of fish (from single statistical areas rather than multiple statistical areas) during the course of the commercial season. As a result, sample data from statistical areas 247-10, 247-20, and 247-30 were combined and sample data from areas 247-70, 247-80, and 247-90 were combined based on historical treatment of these areas. Nearly all samples collected from statistical areas 247-41 and 247-42 were pure loads. Harvest estimates from these two areas were combined previously when it was determined that the estimates of harvest between data stratified and with the data combined were not significantly different and combining the data improved the precision of the overall estimates (Cyr et al. 1997, 1998). In 1998, for 4 days when pure loads were sampled from 247-41 and 247-42, harvest estimates of stocked coho salmon were not significantly different ( $|z| = 0.45$ ,  $P = 0.65$ ) between data stratified by statistical area or with the data combined among the two areas; therefore, data from 247-41 and 247-42 were combined. Combining statistical areas in this fashion allowed the use of sample data from mixed loads collected from adjacent statistical areas. There was no pooling of statistical areas from the Central District eastside setnet fishery because precision of the estimates did not improve appreciably when the areas were combined. Therefore, harvest estimates of marked cohorts were stratified by statistical area and by date.

The majority of the UCI coho salmon harvest in the sampled fisheries occurred in the

**Table 2.-Commercial salmon harvest in Upper Cook Inlet, 1998.**

Fishery	Statistical Area	Chinook	Sockeye	Coho	Pink	Chum	Total Catch	% Coho
<b>Central District Drift</b>								
General (East/West Sides)	245-70,80,90; 244-50,60,70	332	599,202	83,337	200,382	88,036	971,289	8.6%
<b>Central District Set</b>								
<b>Westside</b>								
Western, Kustatan	245-20,30,40,50,55,60	108	23,639	11,127	545	2,023	37,442	29.7%
Kalgin Island	246-10,20	47	23,273	12,830	6,640	380	43,170	29.7%
Chinitna Bay	245-10	0	163	329	46	550	1,088	30.2%
Total		155	47,075	24,286	7,231	2,953	81,700	29.7%
<b>Eastside</b>								
Ninilchik	244-21	1,202	100,913	4,427	93,410	177	200,129	2.2%
Cohoe	244-22	1,065	132,758	3,908	81,474	234	219,439	1.8%
Kalifornsky	244-30	1,943	158,472	4,345	89,387	156	254,303	1.7%
Salamatof	244-40	829	119,890	5,982	67,821	121	194,643	3.1%
Total		5,039	512,033	18,662	332,092	688	868,514	2.1%
<b>Central District Total</b>		5,526	1,158,310	126,285	539,705	91,677	1,921,503	6.6%
<b>Northern District Set</b>								
Susitna Flat	247-41	105	1,580	3,194	707	820	6,406	49.9%
Pt. MacKenzie	247-42	99	763	1,676	316	564	3,418	49.0%
Fire Island	247-43	92	2,890	4,767	1,221	1,053	10,023	47.6%
Knik Arm	247-50	0	2,597	548	0	105	3,250	16.9%
Total		296	7,830	10,185	2,244	2,542	23,097	44.1%
<b>Westside</b>								
Trading Bay	247-10	282	4,474	1,909	559	8	7,232	26.4%
Tyonek	247-20	743	11,466	4,446	1,241	363	18,259	24.3%
Beluga	247-30	420	18,544	6,619	2,768	749	29,100	22.7%
Total		1,445	34,484	12,974	4,568	1,120	54,591	23.8%
<b>Eastside</b>								
Pt. Possession	247-70	572	8,490	5,379	2,839	281	17,561	30.6%
Birch Hill	247-80	43	4,560	3,110	494	13	8,220	37.8%
Number 3 Bay	247-90	115	5,282	2,711	1,410	21	9,539	28.4%
Total		730	18,332	11,200	4,743	315	35,320	31.7%
<b>Northern District Setnet Total</b>		2,471	60,646	34,359	11,555	3,977	113,008	30.4%
<b>Upper Cook Inlet Total</b>		7,997	1,218,956	160,644	551,260	95,654	2,034,511	7.9%

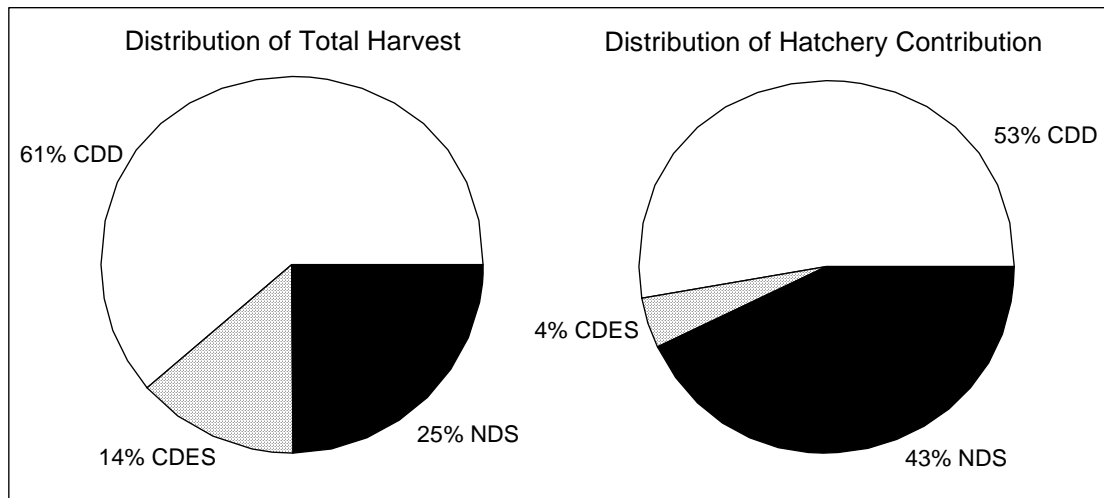
Central District driftnet fishery (61%), followed by the Northern District setnet fishery (25%), and the Central District eastside setnet fishery (14%) (Figure 3). Most of the coded wire tags recovered and most of the harvest of hatchery-produced coho salmon occurred in the Central District driftnet and Northern District setnet fisheries (Tables 4

and 5, Figure 3). Overall, stocked coho salmon represented 6.4% (SE = 0.2%) of the total UCI coho salmon commercial harvest (Table 6, Figure 4). When estimated by fishery, 5.6% (SE = 0.3%) of the Central District driftnet fishery, 1.8% (SE = 0.5%) of the Central District eastside setnet, and 11.1% (SE = 0.4%) of the Northern District setnet

**Table 3.-Commercial coho salmon harvest, harvest dates, and sampling dates for sampled Upper Cook Inlet fisheries, 1998.**

Fishery	Statistical Area	Harvest Dates	Total Coho Harvest	Sampling Dates	Harvest During Sampling	Sampled <sup>a</sup>
Central District Drift	244, 245	6/26-8/7	83,337	6/29-8/7	83,287	99.9%
Central District Set						
Ninilchik	244-21	7/3-8/10	4,427	7/10-8/10	4,417	99.8%
Cohoe	244-22	7/3-8/10	3,908	7/3-8/10	3,908	100.0%
Kalifonsky	244-30	6/29-8/10	4,345	7/10-8/10	4,336	99.8%
Salamatof	244-40	7/10-8/10	5,982	7/10-8/10	5,982	100.0%
Eastside Setnet Total			18,662		18,643	99.9%
Northern District Set						
Westside	247-10,20,30	6/8-8/24	12,974	7/13-8/24	11,308	87.2%
Susitna Flats/Pt. MacKenzie	247-41,42	7/10-8/24	4,870	7/13-8/24	4,666	95.8%
Fire Island	247-43	6/26-8/24	4,767	7/13-8/24	4,641	97.4%
Eastside	247-70/80/90	6/26-9/11	11,200	7/13-9/11	10,918	97.5%
Northern Setnet Total			33,811		31,533	93.3%
Upper Cook Inlet Total			135,810		133,463	98.3%

<sup>a</sup> Percentage of total coho salmon harvest represented by sampling.



**Figure 3.-Distribution of coho salmon harvest and hatchery contribution among three Upper Cook Inlet fisheries: Central District driftnet (CDD), Central District eastside setnet (CDES), and Northern District setnet (NDS), 1998.**

**Table 4.-Harvest, sampling data, and coded wire tag recoveries for selected Upper Cook Inlet commercial coho salmon fisheries, 1998.**

Fishery	Harvest during sampling	Number of coho observed	Number of heads collected	1997 Release Sites			Tag not detected	Tag/Head lost	Total <sup>a</sup>
				Bird	Campbell	Ship			
				Creek	Creek	Creek			
Central District									
Driftnet	83,287	27,008	687	260	118	100	40	6	524
Eastside Setnet									
Ninilchik	4,417	1,373	185	1	0	0	3	61	65
Cohoe	3,908	1,452	198	2	2	2	3	0	9
Kalifornsky Beach	4,336	963	135	2	2	0	1	2	7
Salamatof	5,982	2,145	152	12	0	6	7	3	28
Eastside Setnet Total	18,643	5,933	670	17	4	8	14	66	109
Central District Total	101,930	32,941	1,357	277	122	108	54	72	633
Northern District									
Westside <sup>b</sup>	11,308	5,967	44	19	5	5	10	1	40
Susitna Flat/Pt. MacKenzie <sup>c</sup>	4,666	4,613	350	82	82	164	18	1	347
Fire Island	4,641	3,278	402	188	89	103	7	2	389
Eastside <sup>d</sup>	10,918	8,101	162	82	22	18	17	0	139
Northern District Total	31,533	21,959	958	371	198	290	52	4	915
Upper Cook Inlet Total	133,463	54,900	2,315	648	320	398	106	76	1,548

<sup>a</sup> Total does not include heads collected with coded wire tags of Deep Creek (14) or Moose River (741) origin, 7 heads collected from 1996 releases, 1 unreadable tag, 3 tags from chinook *O. tshawytscha* salmon, and 1 tag of Gastineau Channel origin.

<sup>b</sup> Combination of statistical areas 247-10, 247-20, and 247-30.

<sup>c</sup> Combination of statistical areas 247-41, and 247-42.

<sup>d</sup> Combination of statistical areas 247-70, 247-80, and 247-90.

harvests were composed of hatchery-produced fish (Table 6, Figure 5). The Central District driftnet fishery took 59% of the total commercial harvest of coho salmon stocked into Bird Creek; 58% of the total commercial harvest of coho salmon stocked into Campbell Creek, and 45% of the total commercial harvest of coho salmon stocked into Ship Creek. The Northern District setnet fishery took 37% of the estimated total commercial harvest of coho salmon stocked into Bird

Creek, 41% of the estimated total commercial harvest of coho salmon stocked into Campbell Creek, and 51% of the total commercial harvest of coho salmon stocked into Ship Creek. The Central District eastside setnet fishery took only 4% of the total commercial harvest of coho salmon stocked into Bird Creek and into Ship Creek, and 1% of the coho salmon stocked into Campbell Creek

**Table 5.-Estimated harvest ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in Northern Cook Inlet streams in 1997 by sampled Upper Cook Inlet commercial fisheries, 1998.**

Fishery	Stocking Location						Total	
	Bird Creek		Campbell Creek		Ship Creek			
	r <sub>ij</sub>	SE	r <sub>ij</sub>	SE	r <sub>ij</sub>	SE	r <sub>ij</sub>	SE
Central District								
Drifnet <sup>a</sup>	2,528	151	552	46	1,551	157	4,632	223
Eastside setnet								
Ninilchik <sup>b</sup>	20	19	0	0	0	0	20	19
Cohoe <sup>c</sup>	27	22	5	3	21	33	54	40
Kalifonsky <sup>d</sup>	14	9	8	5	0	0	22	11
Salamatof <sup>e</sup>	<del>111</del>	<del>36</del>	<del>0</del>	<del>0</del>	<del>133</del>	<del>62</del>	<del>243</del>	<del>71</del>
Eastside setnet total	171	47	14	6	154	70	339	85
Northern District								
Westside <sup>f</sup>	100	28	8	2	33	14	141	31
Su Flat/ Pt. MacKenzie <sup>g</sup>	259	25	124	9	850	62	1,233	68
Fire Island <sup>h</sup>	849	61	199	18	743	76	1,791	99
Eastside <sup>i</sup>	<del>397</del>	<del>47</del>	<del>57</del>	<del>10</del>	<del>138</del>	<del>32</del>	<del>592</del>	<del>57</del>
Northern District total	1,605	86	388	23	1,764	104	3,757	137
Upper Cook Inlet Total	4,305	180	954	52	3,469	201	8,728	275

<sup>a</sup> Includes statistical areas 244-50, 244-60, 244-70, 245-70, 245-80, and 245-90.

<sup>b</sup> Statistical area 244-21.

<sup>c</sup> Statistical area 244-22.

<sup>d</sup> Statistical area 244-30.

<sup>e</sup> Statistical area 244-40.

<sup>f</sup> Includes statistical areas 247-10, 247-20, and 247-30.

<sup>g</sup> Includes statistical areas 247-41 and 247-42.

<sup>h</sup> Statistical area 247-43.

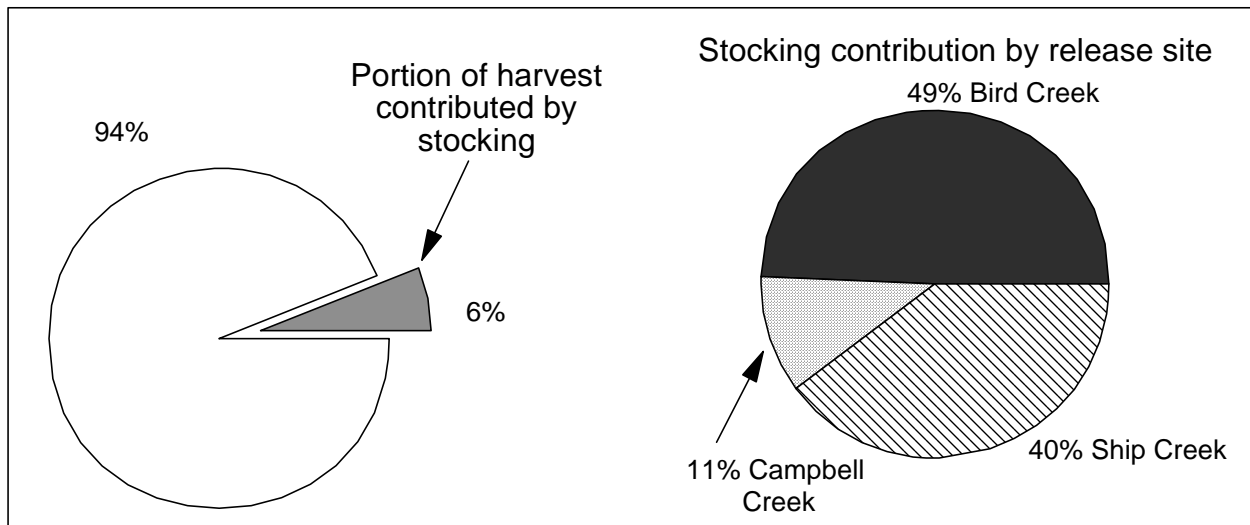
<sup>i</sup> Includes statistical areas 247-70, 247-80, and 247-90.

**Table 6.-Estimated harvest ( $r_{ij}$ ) and standard error (SE) of Northern Cook Inlet hatchery-produced coho salmon released in 1997, in sampled commercial fisheries, 1998.**

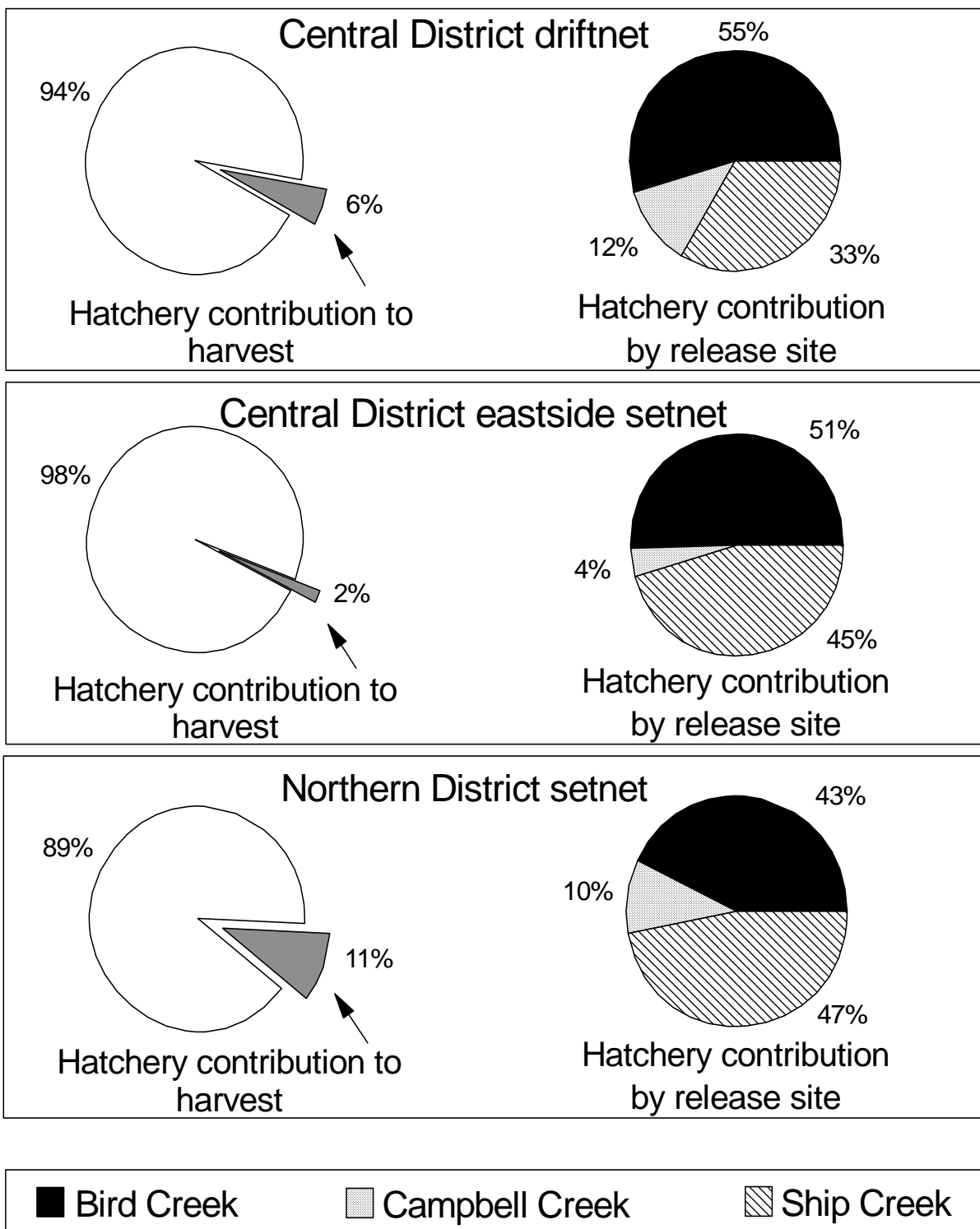
Sampled Fishery	Statistical Area	Coho Harvest	1997 Releases			
			$r_{ij}$	SE	%	SE (%)
<b>Central District Drift<sup>a</sup></b>	244, 245	83,337	4,632	223	5.6%	0.3
<b>Central District Eastside Set</b>						
Ninilchik	244-21	4,427	20	19	0.4%	0.4
Cohoe	244-22	3,908	54	40	1.4%	1.0
Kalifonsky	244-30	4,345	22	11	0.5%	0.2
Salamatof	244-40	5,982	243	71	4.1%	1.2
<b>Eastside Setnet Total</b>		18,662	339	85	1.8%	0.5
<b>Northern District Set<sup>b</sup></b>						
Westside	247-10,20,30	12,974	141	31	1.1%	0.2
Susitna Flats/Pt. MacKenzie	247-41,42	4,870	1,233	68	25.3%	1.4
Fire Island	247-43	4,767	1,791	99	37.6%	2.1
Eastside	247-70/80/90	11,200	592	57	5.3%	0.5
<b>Northern Setnet Total</b>		33,811	3,757	137	11.1%	0.4
<b>Sampled Upper Cook Inlet Fisheries Total</b>		135,810	8,728	275	6.4%	0.2

<sup>a</sup> Excluding Chinitna Bay substat area.

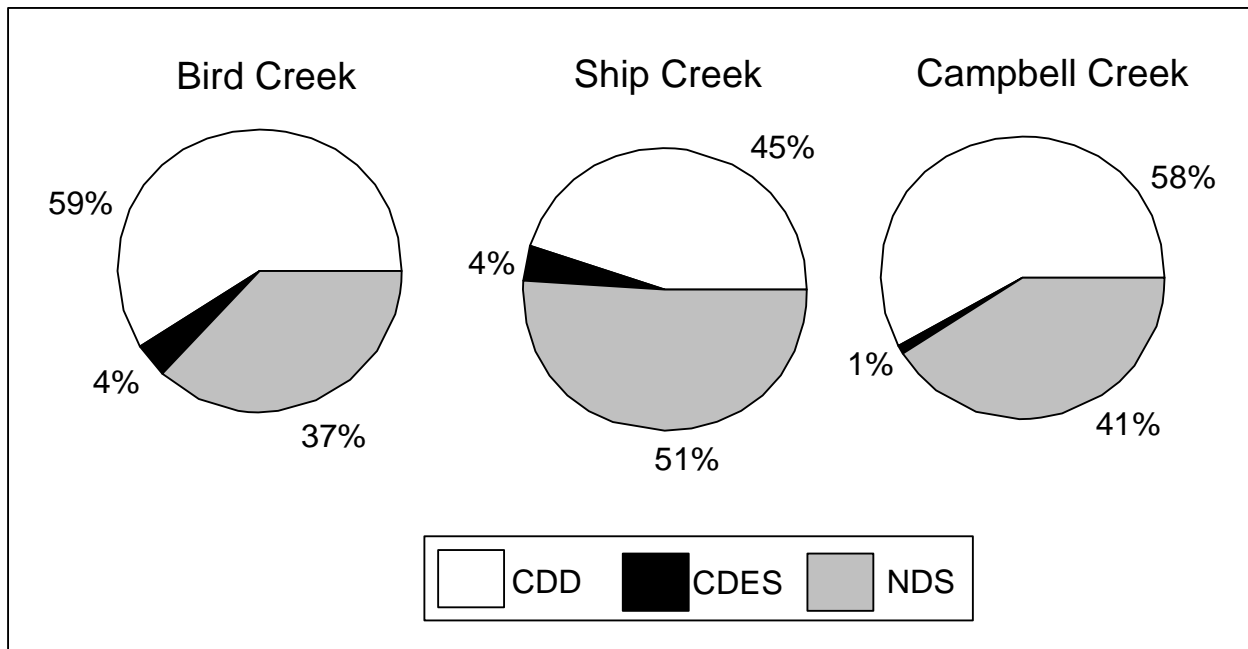
<sup>b</sup> Excluding Knik Arm substat area.



**Figure 4.-Portion of 1998 Upper Cook Inlet coho salmon commercial harvest represented by urban stocked fish.**



**Figure 5.-Portion of 1998 Central District driftnet, Central District eastside setnet, and Northern District setnet coho salmon commercial harvests represented by urban stocked fish.**



**Figure 6.-Percent of the commercial harvest of each 1997 hatchery release group attributed to the Central District driftnet (CDD), Central District eastside setnet (CDES), and Northern District setnet (NDS) fisheries, 1998.**

(Figure 6). Most of the harvest of hatchery coho salmon in the Central District eastside setnet fishery occurred in statistical areas 244-22 and 244-40.

About 80% of the commercially harvested hatchery-origin coho salmon were harvested in the aforementioned fisheries from 17 July to 7 August (Appendices B3-B11). In the Northern District, about 80% of fish stocked into Bird, Campbell, and Ship creeks were harvested around Fire Island (247-43) and in the Susitna Flat/Point MacKenzie (247-41 and 247-42) statistical areas near Anchorage. The returns of coho salmon stocked into Bird Creek in 1997 composed 49% (4,305 coho salmon) of the hatchery returns in all sampled commercial fisheries (Figure 4). Coho salmon smolt stocked into Ship Creek in 1997 provided 40% (3,469 coho salmon) of hatchery returns, and coho salmon smolt stocked into Campbell Creek in 1997

provided 11% (954 coho salmon) of hatchery returns in all sampled fisheries (Figure 4). Contributions to the sampled commercial fisheries from 1996 smolt releases into Bird and Wasilla creeks can be found in Appendices B1 and B2.

### **SPORT HARVEST AND ESCAPEMENT**

An estimated 14,049 (SE = 1,929) coho salmon were harvested in the Ship Creek sport fishery (Howe et al. *In prep c*). A total of 68 coho salmon were missing the adipose fin from 391 fish examined during brood stock collection at Ship Creek from 22-26 August 1998. Of the 68 heads collected during egg takes and sent to the Tag Lab for decoding, 1 head was lost, 8 (12%) did not contain a tag, and 3 (5%) contained tags from 1997 Campbell Creek releases. An estimated 11,917 (SE = 2,210) coho salmon, or 85%, of the Ship Creek sport harvest was from hatchery releases (Table 7). A total of

**Table 7.-Estimated hatchery and natural contributions to total coho salmon runs into Northern Cook Inlet stocked streams, 1998.**

	Hatchery Contribution				Natural Contribution		Total Production	
	Number Released		Total	%			Number	%
	1996	1997						
Bird Creek								
Commercial Harvest	4	4,305	4,309	15%	unknown		4,309	15%
Sport Harvest	unknown	unknown	22,406	80%	unknown		22,406	80%
Escapement <sup>a</sup>	unknown	unknown	1,446	5%	unknown		1,446	5%
Total	4	4,305	28,161	100%			28,161	100%
Campbell Creek								
Commercial Harvest	unknown	954	954	21%	unknown		954	19%
Sport Harvest	unknown	unknown	1,014	22%	153 <sup>b</sup>	28%	1,167	23%
Escapement <sup>a</sup>	unknown	unknown	2,580	57%	388 <sup>b</sup>	72%	2,968	58%
Total	0	954	4,548	100%	541	100%	5,089	100%
Ship Creek								
Commercial Harvest	unknown	3,469	3,469	21%	unknown		3,469	19%
Sport Harvest	unknown	unknown	11,917 <sup>c</sup>	74%	2,132	88%	14,049	75%
Escapement <sup>d</sup>	unknown	unknown	804 <sup>e</sup>	5%	286	12%	1,090	6%
Total	0	3,469	16,190	100%	2,418	100%	18,608	100%

<sup>a</sup> Estimated escapement index from foot surveys.

<sup>b</sup> Natural production estimated using proportion of natural production of coho salmon surveyed during beach seining operations.

<sup>c</sup> Hatchery contribution does not include an estimated 199 coho salmon of Campbell Creek origin.

<sup>d</sup> Estimated escapement from weir count, total production does not include 522 fish collected for brood stock.

<sup>e</sup> Hatchery contribution does not include an estimated 13 coho salmon of Campbell Creek origin.

1,612 coho salmon were counted through the Ship Creek weir, 522 were collected for brood stock resulting in an escapement of 1,090 coho salmon into Ship Creek (Appendix A1). An estimated 804 (SE = 98), or 74%, of these fish were from hatchery releases; the remaining 286 (SE = 98) coho salmon were assumed to be from natural production (Table 7).

In Campbell Creek, an estimated 1,167 (SE = 795) coho salmon were harvested by anglers in 1998 (Howe et al. *In prep c*). A total of 727 coho salmon were examined during beach seining of returning adults from 4 September-25 September 1998, of which 405 fish were missing the adipose fin. An estimated 1,014 (SE = 39), or 87%, of coho salmon in the Campbell Creek sport harvest were from hatchery releases (Table 7). The coho salmon escapement index into Campbell Creek on 30 September was 2,968 fish (Appendix A2). An estimated 2,580 (SE = 118), or 87%, of the indexed escapement were from hatchery releases; the remaining 388 (SE = 118) coho salmon were assumed to be from natural production (Table 7).

At Bird Creek, anglers harvested an estimated 22,406 (SE = 2,901) coho salmon in 1998 (Howe et al. *In prep c*). A coho salmon escapement index conducted on 2 October 1998 in Bird Creek and Penguin Creek (a tributary of Bird Creek) counted 1,446 coho salmon (Appendix A2).

Aerial surveys conducted on 1 and 16 October 1998 tallied a total of 2,954 and 1,850 coho salmon in Twentymile and Placer (including sloughs and Skookum Creek) river drainages, respectively (Appendix A3). A U.S. Forest Service (USFS) foot survey counted an additional 500 fish in Explorer Creek (a tributary of Placer River drainage). A total of 870 coho salmon was observed in selected Portage Creek sloughs and streams (Appendix A3). Turnagain Arm escapement surveys

were conducted later in the season because peak spawning of these native coho salmon stocks is generally 3-6 weeks later than streams stocked with Little Susitna brood stock.

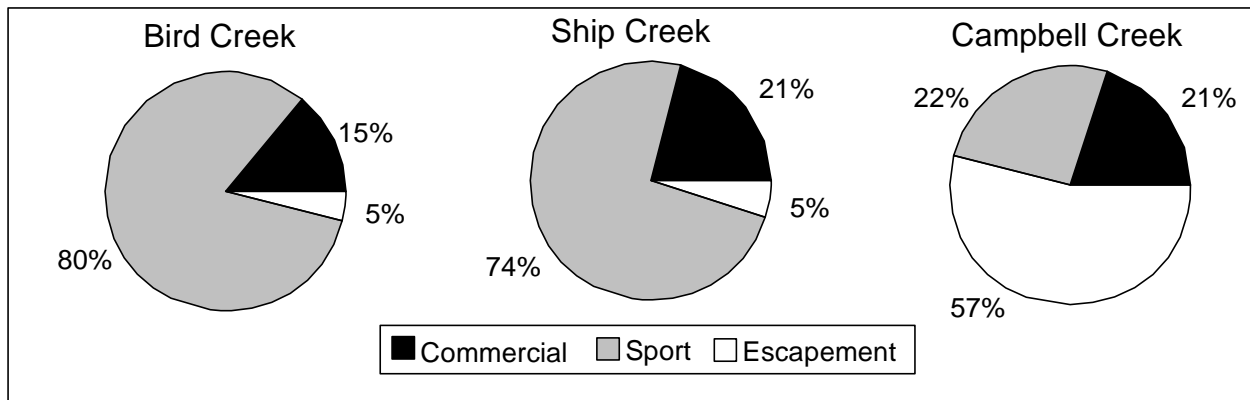
## RETURNS

Total returns of coho salmon to urban area streams are made up of three measurable components: commercial harvest, inriver sport harvest, and spawning escapement (Table 7). The spawning escapements and estimates of commercial harvest are presented in this report. Total inriver sport harvest was estimated by the SWHS (Howe et al. *In prep c*). Approximately 15% of Bird Creek hatchery returns, 21% of Campbell Creek hatchery returns, and 21% of Ship Creek hatchery returns were harvested by the commercial fishery (Figure 7).

From 1997 to 1998 at Ship Creek, sport effort decreased slightly, but catch increased by over 8,000 coho salmon, and harvest by over 4,500 (Howe et al. *In prep c*; Table 8). Effort, catch and harvest increased substantially at Bird Creek, but these decreased slightly at Campbell Creek (Table 8). Overall, the coho salmon stocking program met expectations. Total effort in Bird, Campbell, and Ship creeks was 70,301 angler-days in 1998 compared to the 1988-1992 prestocking annual average of 34,699 angler-days. Total catch was 57,903 coho salmon, compared to a prestocking average of 3,107 coho salmon; total harvest was 37,622 coho salmon compared to the prestocking average of 2,516 coho salmon (Table 8; Figure 8).

## MARINE SURVIVAL

Overall marine survival of the three major coho salmon cohorts released in 1997 and recovered in 1998 was 8.2% (SE = 0.6%; Table 9). Survival estimates ranged from 6.4% (SE = 0.2%) for smolt released into



Notes:

For commercial harvest, estimate of hatchery contribution to the harvest is from catch sampling data.

Estimate of sport harvest of coho salmon from Statewide Harvest Survey (Howe et al. *In prep c*). Hatchery releases in 1997 are assumed to comprise the total harvest at Bird Creek. Estimate of hatchery contribution to Campbell and Ship creeks sport harvests are based on data collected during beach seining in Campbell Creek and brood stock collection in Ship Creek.

Estimate of hatchery contribution to Bird and Campbell creeks escapements are minimum estimates of the total escapements from foot surveys. Estimate of hatchery contribution to Campbell and Ship creeks escapements are based on data collected during beach seining in Campbell Creek and brood stock collection in Ship Creek.

**Figure 7.-Distribution of coho salmon total returns among commercial and sport fisheries and the escapement in three stocked sites, 1998.**

Campbell Creek to 9.6% (SE = 1.0%) for smolt released into Bird Creek. Estimated survival for smolt released into Ship Creek was 7.0% (SE = 1.0%). Depending on release site, escapements were indexed and sport harvests and escapements were not sampled. Therefore, estimates of total return, and thus survival, of stocked coho salmon are biased low.

## DISCUSSION

### COMMERCIAL CATCH ASSESSMENT

The 1998 sampling goal of examining 25% of the Central District driftnet harvest and 15% of the coho salmon harvested from each Central District eastside setnet statistical area

was met. Approximately 32% of the Central District driftnet harvest was sampled and 31% to 49% of harvests in each Central District eastside setnet statistical area were sampled. The goal of examining 35% of the coho salmon harvested from each Northern District statistical area was met in most areas except for statistical areas 247-10, 247-20, and 247-30. It was not always possible to examine pure loads from these statistical areas as tender operators would often mix coho salmon from these areas with coho salmon harvested in adjacent or other statistical areas prior to reaching port. When harvests from statistical areas 247-10, 247-20, and 247-30

**Table 8.-Sport effort, and catch and harvest of coho salmon, in Anchorage urban streams stocked with coho salmon, 1988–1998.**

Year	Effort				Catch <sup>a</sup>				Harvest			
	Ship	Bird	Campbell	Total	Ship	Bird	Campbell	Total	Ship	Bird	Campbell	Total
1988	14,115	9,532	4,729	28,376					2,128	1,710	0	3,838
1989	16,424	5,844	1,942	24,210					1,467	899	28	2,394
1990	15,112	9,138	3,983	28,233	1,220	811	0	2,031	818	535	0	1,353
1991	29,768	7,551	1,977	39,296	1,384	1,372	89	2,845	1,168	1,099	25	2,292
1992	40,513	11,352	1,515	53,380	3,142	1,279	24	4,445	1,911	785	8	2,704
1993	40,815	12,852	9,073	62,740	3,876	7,799	6,894	18,569	2,579	6,195	3,942	12,716
1994	40,727	12,357	8,036	61,120	4,239	7,169	4,725	16,133	3,011	5,425	1,256	9,692
1995	51,087	15,947	10,457	77,491	5,482	5,639	4,910	16,031	3,222	4,121	1,947	9,290
1996	42,454	12,003	5,225	59,682	7,710	9,675	3,474	20,859	5,369	6,934	1,458	13,761
1997	47,826	12,136	5,897	65,859	13,448	9,097	3,006	25,551	9,434	6,771	1,651	17,856
1998	44,670	20,797	4,834	70,301	21,733	33,546	2,624	57,903	14,049	22,406	1,167	37,622
prestocking mean <sup>b</sup>												
	23,186	8,683	2,829	34,699	1,915	1,154	38	3,107	1,498	1,006	12	2,516

Sources: Mills 1989-1994; Howe et al. 1995 and 1996, *In prep* a, b, and c (revised estimates for years 1996-1998).

<sup>a</sup> Estimates of catch not available prior to 1990.

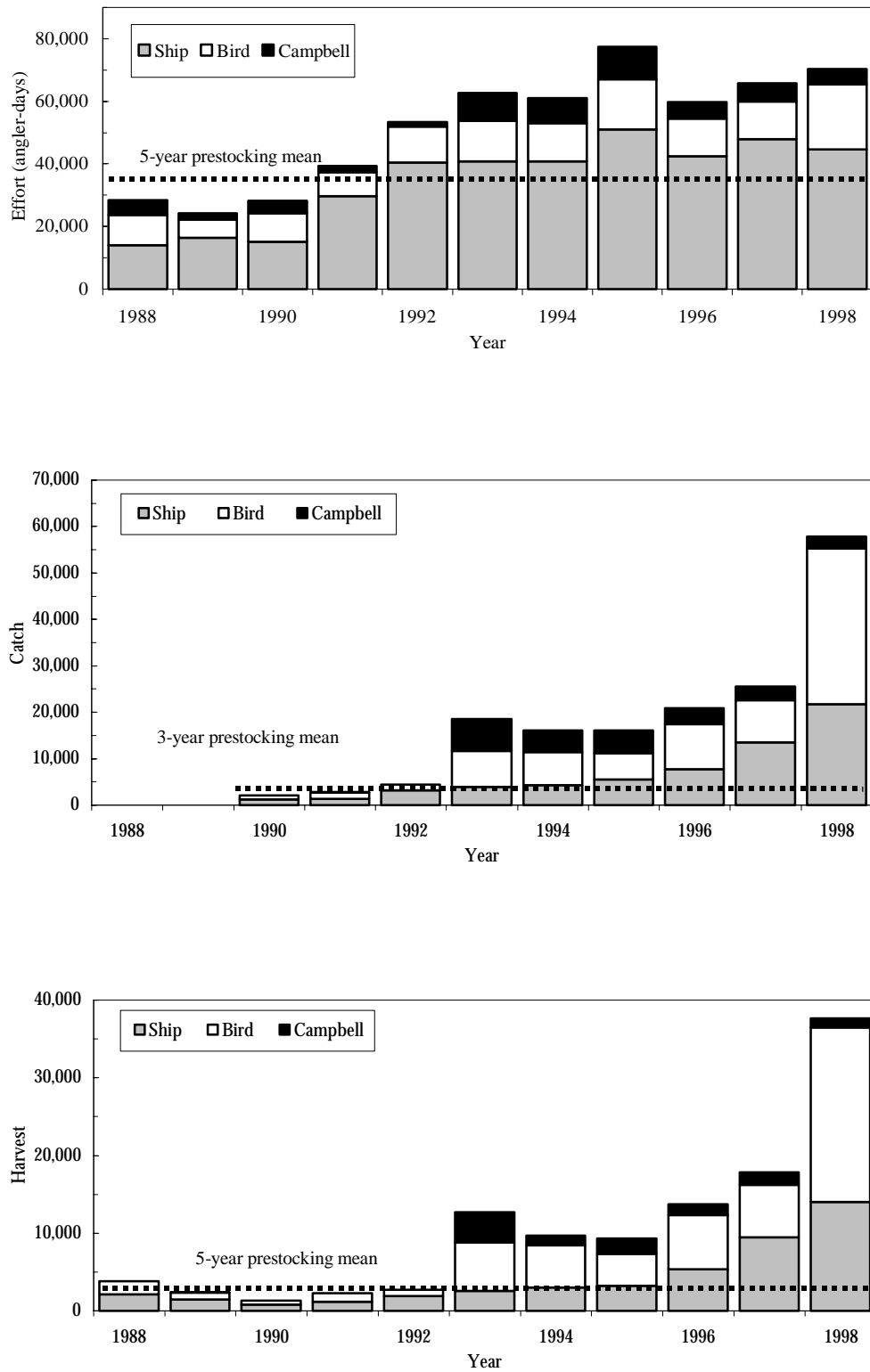
<sup>b</sup> 1988-1992 for effort and harvest; 1990-1992 for catch.

were combined, 46% of the total harvest was sampled. Sampling in the remaining Northern District statistical areas (247-41, 247-42, 247-43, 247-70, 247-80, and 247-90) ranged from 50% to 100% of the total harvest for each statistical area. Sample crews were able to examine greater proportions of fish and exceed sampling goals due to low volumes of commercially harvested coho salmon and organized sampling efforts.

Sampling effort of the commercial harvest provided relatively precise estimates. Relative precision of the total harvest of hatchery-produced fish by the UCI commercial fisheries was 6%. Estimates were most precise for the Northern District setnet

fishery (7%) and the Central District driftnet fishery (9%), and much less precise for the Central District eastside setnet fishery (49%). The estimated harvest by the eastside setnet fishery was not as precise due to a smaller than average coho salmon harvest, recovery of fewer tags from this fishery, and contribution of fewer stocked fish to the overall harvest. The target precision levels by fishery were 20% for the Northern District setnet fishery, 10% for the Central District driftnet fishery, and 30% for the Central District eastside setnet fishery.

Target precision levels for commercial harvest estimates by release site were 10% for each stream. Harvest estimates of coho salmon



**Figure 8.-Sport effort, and catch and harvest of coho salmon in Anchorage urban streams stocked with coho salmon, 1988–1998.**

**Table 9.-Estimates and associated standard errors used to estimate marine survival of coho salmon stocked into Northern Cook Inlet streams in 1997 based on return data in 1998.**

	Smolt Releases <sup>a</sup>	Commercial		Sport Harvest		Escapement		Total Return <sup>b</sup>		Estimated Smolt Survival <sup>c</sup>	
		Harvest									
		Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Bird Creek	294,565	4,305	180	22,406 d	2,901	1,446 e		28,157	2,907	0.096	0.010
Campbell Creek	71,519	954	52	1,014 f	39	2,580 g	118	4,548	134	0.064	0.002
Ship Creek	232,066	3,469	201	11,917 h	2,210	804 i	98	16,190 <sup>j</sup>	2,221	0.070	0.010
Total	598,150	8,728	275	35,337	3,647	4,830	153	48,895	3,661	0.082	0.006

<sup>a</sup> Starkey et al. 1999. Standard error of smolt releases unavailable because average fish weight and sampling variance were not recorded for individual dip nets of fish when moving smolt between raceways.

<sup>b</sup> Does not include coho salmon expected to return in low numbers in 1999.

<sup>c</sup> Standard error of survival estimates are biased low because sampling variance not estimated for total escapement.

<sup>d</sup> Estimated total harvest (Howe et al. *In prep* c). Total harvest assumed to be from 1997 releases, though negligible returns from previous years are likely included.

<sup>e</sup> Escapement index from foot survey represents a minimal estimate of the total escapement, with no estimate of sampling variability available.

<sup>f</sup> Hatchery contribution estimated using data from beach seining at Campbell Creek.

<sup>g</sup> Escapement index from foot survey represents a minimal estimate of the total escapement, with no estimate of sampling variability available. Hatchery contribution and associated standard error estimated using data from beach seining at Campbell Creek.

<sup>h</sup> Hatchery contribution estimated using data from Ship Creek brood stock collection.

<sup>i</sup> Escapement from weir count. Hatchery contribution and associated standard error estimated using data from Ship Creek brood stock collection.

<sup>j</sup> Includes an estimated 323 hatchery coho salmon collected for brood stock.

stocked into Bird, Campbell, and Ship creeks had good precision (relative precision < 12%) because: (1) at least 30% of the smolt in each release group were tagged, and (2) a large sample from the commercial harvest was obtained.

The pattern of commercial coho salmon harvest was typical of previous years. Since 1993, the Central District driftnet fishery has harvested 45% or more of the total coho

salmon harvested in the sampled UCI fisheries, the Central District eastside setnet fishery has harvested at least 12%, and the Northern District setnet fishery has harvested at least 24%.

Coho salmon harvest in the Central District driftnet and eastside setnet fisheries fell below the 1993-1997 averages of 182,060 fish and 43,462 fish, respectively. The 1998 harvests were similar to 1997 harvests of 79,094

(driftnet) fish and 19,668 (eastside setnet) fish, when poor returns of wild coho salmon throughout UCI prompted fisheries managers to use emergency order authority to close commercial fisheries and restrict sport fisheries. In 1998 commercial fishing periods in the Central District driftnet and eastside setnet fisheries were often restricted primarily due to low returns of sockeye salmon to Kenai River. There were fewer commercial fishing periods, nearly all commercial fishing periods were regularly scheduled openings (few additional emergency openings were allowed), and time and area restrictions were placed on the existing fishing periods.

Several commercial fishing periods were also restricted in the Northern District setnet fisheries. Historically, the majority of coho salmon harvest occurs from 15 July through 31 July. A harvest of 33,811 coho salmon in 1998 fell below the 1993-1997 average harvest of 91,106 fish and was at least partially a result of emergency order closures of fishing periods in the Northern District on 20, 27, and 31 July. Though the overall Northern District harvest was similar to the harvest of 37,252 fish in 1997, there was a shift in the distribution of coho salmon harvest among statistical areas.

The Northern District westside (statistical areas 247-10, 247-20, and 247-30) has averaged about 64% of the Northern District harvest from 1993-1997. In 1998 the Northern District westside harvest contributed only 38% of the total harvest. Since 1994 there has been a steady decrease in the coho salmon harvest in the Northern District westside setnet fishery, from a high of 94,401 fish in 1994 to a low of 12,974 fish in 1998. The cause of this decline, at least in part, appears to be related to a decrease in the number of commercial fishermen working permits in this area. Factors for this decrease may include fewer fishing periods, restrictions

on existing fishing periods, remote location of permit sites, and fewer fishing tenders and local sites for fishermen to sell caught fish. In the past, fishermen working permits in the Northern District westside sold their fish to tender boats based out of Anchorage or Kenai Peninsula. However, in the last several years there has not been a consistent Anchorage-based tender working this area and the Kenai Peninsula-based tender boats have usually been located in the 247-30 statistical area, making it more difficult for fishermen in 247-10 and 247-20 to sell their fish.

Coho salmon harvest in the Northern District eastside (statistical areas 247-70, 247-80, and 247-90) has averaged about 17% of the Northern District harvest from 1993-1997. In 1998 the Northern District eastside harvest contributed 33% of the total Northern District harvest. The majority of coho salmon harvest in the Northern District eastside occurs from 26 July through 23 August; thus, emergency order closures of fishing periods in the Northern District in July did not affect the Northern District eastside harvest as much. Additionally, fishing period closures and restrictions placed on the Central District driftnet and Central District eastside setnet fisheries in late July and August may have allowed a greater number of coho salmon to reach Northern District eastside statistical areas.

The proportion of hatchery-stocked coho salmon in the sampled fisheries was comparable to past years. The 1998 relative contributions to the Central District driftnet and eastside setnet fisheries of 6% and 2% were similar to the 1993-1997 average proportions of 7% and 4%, respectively. The 1998 relative contributions to the Northern District westside (247-10, 247-20, 247-30), eastside (247-70, 247-80, 247-90), Su Flats/Pt. MacKenzie (247-41, 247-42), and Fire Island (247-43) statistical areas of 1%,

5%, 25%, and 38%, respectively, were similar to the 1993-1998 average proportions of 3%, 6%, 23%, and 30%. Slight differences in the proportion of hatchery-stocked coho salmon in the sampled fisheries were most likely due to the location and timing of restrictions placed on these fisheries and smaller than average coho salmon harvests.

Estimates of harvest of all marked cohorts observed within the statistical area/day strata are not independent. Incorporation of covariance terms in previous years (Hoffmann and Hasbrouck 1994, Stratton et al. 1996) resulted in insignificant differences in total variance estimates (Bernard and Clark 1996). Examination of covariance terms in 1998 calculations indicated bias in variance is negligible.

## **SPORT FISHERY**

We believe results presented in this report and field observations of the sport fisheries indicate that the urban coho salmon stocking program exceeded all expectations in 1998.

The NCI urban area coho salmon stocking program is considered successful if it increases recreational angler effort by 25,000 angler-days and sport harvest by 10,000 coho salmon among all stocked streams. The prestocking 5-year mean (1988-1992) total effort in Ship, Campbell, and Bird creeks was 34,699 angler days with a mean total harvest of 2,516 coho salmon (Mills 1989-1993). The targeted increase in harvest of 10,000 fish was surpassed in 1998 with an increase of 35,106 coho salmon over the prestocking 5-year mean (Table 8; Howe et al. *In prep c*). The estimated harvest is species specific so this increase is easily quantified.

The ultimate measure of success, however, is increased angler effort. The Statewide Harvest Survey estimates angling effort for all species combined. Increased angler effort for

a specific species is not easily quantified and may be confounded by fluctuations in effort of other fisheries. The targeted increase in angler effort of 25,000 angler-days was exceeded with an increase of 35,602 angler-days of effort over the prestocking 5-year mean effort, and an increase of 16,921 angler-days of effort compared to effort in 1992, the last year before stocked fish returned (Table 8; Mills 1993; Howe et al. *In prep c*). The true increase in angler effort for coho salmon may be masked by the continually increasing popularity of the chinook salmon fishery in Ship Creek. This fishery has grown dramatically in recent years and is included in the estimate of angler effort. In addition, a weakness of using the SWHS is that the survey targets households with a licensed angler. Field observations indicate that urban streams, especially Campbell Creek, are fished primarily by young anglers who are not required to purchase a license. Households in which youths fish but adults do not purchase a fishing license have no chance of being sampled by the SWHS. Thus, estimates of harvest and effort in Campbell Creek are considered minimal estimates.

A substantial increase in the catch of coho salmon has occurred in Ship, Campbell, and Bird creeks since the start of the stocking program. The prestocking 3-year (SWHS did not estimate catch until 1990) mean catch for Ship, Campbell, and Bird creeks was 3,107 coho salmon (Mills 1991-1993). Catch increased by 54,796 coho salmon in 1998 relative to the prestocking 3-year mean (Table 8; Howe et al. *In prep c*).

Past observations in Campbell Creek indicated that the majority of coho salmon often stay in the lower reaches of the creek or Campbell Lake from late July through mid to late August and move into the upper areas of the creek in late August or early September.

In 1998 sport anglers concentrated their efforts primarily in the areas of Campbell Creek from Dowling Road downstream to Dimond Boulevard in July and August. In September most angler effort occurred from Dowling Road upstream to the ADF&G marker near Piper Street. The catch and harvest of 2,624 and 1,167 coho salmon, respectively, in Campbell Creek were similar to the 1997 catch and harvest of 3,006 fish and 1,651 fish (Table 8; Howe et al. *In prep* b, c). Many coho salmon caught in Campbell Creek after the peak of the run are not retained due to the condition of the pre-spawning and spawning fish. Of the estimated 2,624 coho salmon caught by anglers at Campbell Creek in 1998, about 56% (1,457) were released.

Hatchery coho salmon returning to Bird and Ship creeks were available from mid-July through late August. The peak of the run occurred during the last week of July through the first week of August. Because Wasilla Creek was dropped from the coho salmon smolt stocking program, approximately 140,000 additional smolt were available for stocking and were released into Bird Creek, resulting in a total release of nearly 300,000 smolt in 1997. Combined with UCI commercial fishing restrictions, this resulted in a record return of coho salmon to Bird Creek in 1998. Restrictions on UCI commercial fisheries also appeared to generate a record return of coho salmon to Ship Creek. Sport anglers at both creeks were able to enjoy much higher than average (1993-1997) catch and harvest rates. The catch and harvest of 33,546 and 22,406 coho salmon, respectively, in Bird Creek were about four times greater than the 1993-1997 average catch and harvest of 7,876 fish and 5,889 fish (Mills 1994, Howe et al. 1995 and 1996, *In prep* a, b, and c). The catch and harvest of 21,733 and 14,409 coho salmon, respectively, in Ship Creek were more than three times the

1993-1997 average catch and harvest of 6,951 fish and 4,723 fish (Mills 1994, Howe et al. 1995 and 1996, *In prep* a, b, and c).

The fisheries in Bird and Ship creeks, being essentially intertidal, were more closely related to the tides than at Campbell Creek. Greatest success appeared to occur on incoming and high tidal periods, although during the peak of the return, fish were available at all tide stages. Approximately 33% of the coho salmon caught in Bird Creek were released and 35% of the coho salmon in Ship Creek were released. Angler effort in Bird Creek was about 8,661 angler-days greater in 1998 than in 1997, while in Ship Creek angler effort in 1998 was about 3,156 angler-days less than that in 1997 (Howe et al. *In prep* b and c). The increase in angler effort at Bird Creek was likely a result of a greater number of adult coho salmon available to sport anglers due to the increased number of smolt stocked into Bird Creek in 1997 and restrictions placed on UCI commercial fisheries in 1998.

## ESCAPEMENT

The individual biological escapement goals (BEGs) of 200 coho salmon into Ship and Campbell creeks were met in 1998. The weir count at Ship Creek was over six times greater than the BEG and the foot survey at Campbell Creek was nearly 15 times greater than the BEG. The coho salmon fishery at Ship Creek has become increasingly popular with sport anglers while angler effort at Campbell Creek has seen an overall decline. Since 1996, in order to reduce run size in Campbell Creek and increase angler opportunity in Ship Creek, coho salmon smolt stocking in Campbell Creek has been reduced by about one half with the difference being stocked into Ship Creek.

The straying of hatchery-reared coho salmon from stream of release was not tested in 1998 because no significant straying had been

detected in the past. However, hatchery personnel collected heads from Ship Creek brood stock missing the adipose fin and sent them to the Tag Lab for decoding. It appeared a stray rate of about 5% occurred when three tags of Campbell Creek origin were detected. However, part of the 1997 release of coho salmon smolt into Ship Creek were from the Campbell Creek raceway (Ft. Richardson hatchery) and had been hand counted and separated so no smolt containing a Campbell Creek CWT would be released into Ship Creek. Due to human error while splitting the raceway, it was possible that a small number of smolt containing a Campbell Creek CWT were mixed in with the Ship Creek smolt and released into Ship Creek.

Prior to coho salmon stocking, Bird Creek had no significant natural spawning population of coho salmon; therefore, no BEG has been set for Bird Creek. Escapement indices of coho salmon into Bird Creek from 1993-1997 ranged from 139 to 603 fish. A record escapement of 1,446 coho salmon was counted in 1998.

Sufficient coho salmon spawning escapement data has not been collected yet to set BEGs for wild coho salmon escapements in Twentymile and Placer river drainages and Portage Creek drainage.

Aerial escapement surveys of Twentymile and Placer River drainages and Portage Creek drainage resulted in record escapement counts of 2,954, 1,850, and 870 coho salmon, respectively. A USFS foot escapement index tallied an additional 500 coho salmon in Explorer Creek (a tributary of Placer River). Record escapement counts into area streams were likely due to the timing and number of restrictions placed on UCI commercial fisheries. The increase in Bird Creek's escapement index was also a result of the elevated number of smolt stocked. The coho

salmon escapement count in Ship Creek remained similar to counts in previous years.

## **MARINE SURVIVAL**

The total estimated marine survival for coho salmon smolt stocked in 1997 and returning as adults in 1998 was 2.6% greater than the estimated marine survival for coho salmon stocked in 1996 that returned in 1997. Prior to 1998 the total estimated marine smolt survival ranged from a high of 10.6% (for fish stocked in 1993 and returning in 1994) to a low of 6.3% (for fish stocked in 1996 and returning in 1997) and doesn't show much variation among years.

## **RECOMMENDATIONS**

Our results justify continuation of the stocking program. Additional streams flowing into Knik and Turnagain arms may be stocked depending on availability of brood stock. The terminal and commercial sampling programs should continue to evaluate and measure the success of the stocking program. The commercial sampling program will be necessary for future assessment of wild stock from Cottonwood Creek (drains into Knik Arm) that will be coded wire tagged and released in 1999.

The 1997 hatchery releases used separate CWT code numbers for coho salmon smolt released into each creek. Future coho salmon smolt releases should continue to use individual tag codes for each cohort to keep project data analysis consistent. Other recommendations for the future include modified sampling of several statistical areas in the Northern District (i.e., 247-10, 247-20, 247-30, 247-50, 247-70, 247-80, and 247-90) if feasible, to obtain samples specific to each statistical area. This could be accomplished by placing technicians onboard tenders, closely following buying patterns of processors inseason, and obtaining assistance from tender boat operators and processors in keeping harvested coho salmon separated by

statistical area. These steps would improve our ability to sample pure loads of coho salmon harvested in these statistical areas.

## ACKNOWLEDGMENTS

The data presented here result from the efforts of many individuals. Bob McFadden, Heather Stewart, Kris Heikkila, and Tracy Smith conducted commercial catch sampling in Anchorage, assisted with escapement foot surveys of Anchorage area streams, and assisted Elmendorf Hatchery personnel with brood stock collection in Ship Creek. Bob McFadden, Heather Stewart, and Kris Heikkila conducted limited regulation enforcement. Bob McFadden assisted in sampling coho salmon in Campbell Creek. Dave Waltemyer, Kim Rudge, and Jay Carlon supervised 10 technicians from the Soldotna ADF&G office who collected data from the Central District. Anna Sharp, Karen Crandall, Barbara Haar, and the rest of the staff at the Tag Lab in Juneau were always helpful and patient in helping us deal with coded wire tag data. The U.S. Forest Service (USFS) Glacier Ranger District shared coho salmon escapement data from foot surveys they conducted on Turnagain Arm streams.

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**APPENDIX A. COHO SALMON ESCAPEMENT COUNTS AT  
BIRD, CAMPBELL, AND SHIP CREEKS AND SELECTED  
TURNAGAIN ARM STREAMS**

**Appendix A1.-Coho salmon weir counts in  
Ship Creek, 1998.**

Date	Adipose Fin		Coho Examined	
	Present	Absent	Daily	Total
7/2	7	0	7	7
7/3 <sup>a</sup>			0	7
7/4 <sup>a</sup>			0	7
7/5 <sup>a</sup>			0	7
7/6 <sup>a</sup>			0	7
7/7 <sup>a</sup>			0	7
7/8 <sup>a</sup>			0	7
7/9	6	0	6	13
7/10	5	0	5	18
7/11	5	1	6	24
7/12 <sup>a</sup>			0	24
7/13 <sup>a</sup>			0	24
7/14	10	2	12	36
7/15	15	2	17	53
7/16	7	0	7	60
7/17	15	0	15	75
7/18	31	6	37	112
7/19	24	2	26	138
7/20	50	10	60	198
7/21	42	3	45	243
7/22	63	11	74	317
7/23	7	4	11	328
7/24	6	0	6	334
7/25 <sup>a</sup>			0	334
7/26 <sup>a</sup>			0	334
7/27 <sup>a</sup>			0	334
7/28 <sup>a</sup>			0	334
7/29	116	19	135	469
7/30	97	15	112	581
7/31	73	13	86	667
8/1	51	12	63	730
8/2	39	10	49	779
8/3	31	6	37	816
8/4	14	1	15	831
8/5	86	14	100	931
8/6	294	65	359	1,290
8/7	146	31	177	1,467

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**Appendix A1.-Page 2 of 2.**

Date	Adipose Fin		Coho Examined	
	Present	Absent	Daily	Total
8/8	36	6	42	1,509
8/9	5	1	6	1,515
8/10	8	3	11	1,526
8/11	21	0	21	1,547
8/12	23	0	23	1,570
8/13	10	0	10	1,580
8/14	18	0	18	1,598
8/15 <sup>a</sup>			0	1,598
8/16 <sup>a</sup>			0	1,598
8/17 <sup>a</sup>			0	1,598
8/18 <sup>b</sup>	14	0	14	1,612
<b>Total</b>	1,375	237	14	1,612
<b>Escapement</b>				1,090 <sup>c</sup>

<sup>a</sup> Weir open - not checked.

<sup>b</sup> Last day weir in operation.

<sup>c</sup> Total does not include 522 coho salmon retained for brood stock.

**Appendix A2.-Coho salmon escapement index counts from foot surveys in Bird and Campbell creeks, 1998.**

Stream	Date	Live	Dead	Total
<b>Bird Creek Drainage</b>				
Bird Ck. Falls downstream to Penguin Ck.	02-Oct	106	1	107
Penguin Ck.	02-Oct	1,079	49	1,128
Bird Ck. from Penguin Ck. to Seward Hwy.	02-Oct	<u>195</u>	<u>16</u>	<u>211</u>
Total		1,380	66	1,446
<b>Campbell Creek Drainage</b>				
Upper South Fork	30-Sep	211	2	213
Lower South Fork	30-Sep	995	17	1,012
Upper North Fork	30-Sep	174	3	177
Lower North Fork	30-Sep	139	12	151
Piper St. to Folker St.	30-Sep	452	18	470
Folker St. to C St	30-Sep	<u>916</u>	<u>29</u>	<u>945</u>
Total		2,887	81	2,968

**Appendix A3.-Coho salmon escapement index peak counts from aerial surveys in selected Turnagain Arm streams, 1994-1998.**

Stream	1994	1995	1996	1997	1998
<b>Twentymile River Drainage</b>					
Ahjo Creek	75	65	0	0	60
NE Fork	75	210	275	140	260
Mainstem	780	560	940	770	2,500
Beaver Pond	<sup>a</sup>	120	30	90	80
Glacier River	50	0	<sup>a</sup>	<sup>a</sup>	40
Upper Carmen River	0	0	0	<sup>a</sup>	14
South Fork Carmen River	<u>6</u>	<u>0</u>	<u>0</u>	<sup>a</sup>	<u>0</u>
Total	986	955	1,245	1,000	2,954
<b>Portage Creek Drainage</b>					
Mainstem <sup>b</sup>	40	10	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>
Upper Railroad Slough	0	210	120	<sup>c</sup>	540
Lower Railroad Slough	0	40	60	75	330
Williwaw <sup>b</sup>	30	35	2	0	0
Placer Creek	<u>0</u>	<u>57</u>	<u>10</u>	<u>5</u>	<sup>c</sup>
Total	70	352	192	80	870
<b>Placer River Drainage</b>					
Sloughs and Mainstem	55	90	45	110	370
Skookum Creek	750	720	410	420	1,480
Explorer Creek <sup>b</sup>	<u>804</u>	<u>350</u>	<u>75</u>	<u>30</u>	<u>500</u>
Total	1,609	1,160	530	560	2,350

<sup>a</sup> Glacial water, no count possible.

<sup>b</sup> Foot survey counts conducted by US Forest Service personnel.

<sup>c</sup> Creek and slough dry, no count possible.



**APPENDIX B. ESTIMATES BY RELEASE SITE OF COHO  
SALMON STOCKED IN 1996 AND 1997 THAT WERE  
HARVESTED IN SAMPLED UPPER COOK INLET  
COMMERCIAL FISHERIES IN 1998**

**Appendix B1.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Central District (244-00, 245-00) driftnet commercial harvest, 1998.**

Date	Coho Harvest	Wasilla Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/26-6/29/98	1,162	0	0	0	0	0.00%	0.00
07/03/1998	3,360	0	0	0	0	0.00%	0.00
07/06/1998	4,790	0	0	0	0	0.00%	0.00
07/10/1998	23,898	0	0	0	0	0.00%	0.00
07/11/1998	126	0	0	0	0	0.00%	0.00
07/13/1998	187	0	0	0	0	0.00%	0.00
07/15/1998	437	0	0	0	0	0.00%	0.00
07/17/1998	31,134	10	10	10	10	0.03%	0.00
08/01/1998	498	0	0	0	0	0.00%	0.00
08/02/1998	945	0	0	0	0	0.00%	0.00
08/03/1998	7,949	0	0	0	0	0.00%	0.00
08/05/1998	254	0	0	0	0	0.00%	0.00
08/07/1998	8,597	0	0	0	0	0.00%	0.00
<b>Total<sup>a</sup></b>	83,337	10	10	10	10	0.01%	0.00

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B2.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Northern District eastside (247-70, 247-80, 247-90) setnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/26-7/13/98	584	0	0	0	0	0.00%	0.00
07/17/1998	1,129	0	0	0	0	0.00%	0.00
07/24/1998	1,331	0	0	0	0	0.00%	0.00
08/03/1998	1,047	0	0	0	0	0.00%	0.00
08/07/1998	618	0	0	0	0	0.00%	0.00
08/10/1998	657	4	3	4	3	0.57%	0.00
08/14/1998	1,785	0	0	0	0	0.00%	0.00
08/17/1998	1,804	0	0	0	0	0.00%	0.00
08/21/1998	956	0	0	0	0	0.00%	0.00
08/24/1998	521	0	0	0	0	0.00%	0.00
08/28/1998	282	0	0	0	0	0.00%	0.00
08/31/1998	38	0	0	0	0	0.00%	0.00
09/04/1998	285	0	0	0	0	0.00%	0.00
09/07/1998	134	0	0	0	0	0.00%	0.00
09/11/1998	29	0	0	0	0	0.00%	0.00
<b>Total<sup>a</sup></b>	11,200	4	3	4	3	0.03%	0.00

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B3.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1997 by release site in Upper Cook Inlet Central District (244-00, 245-00) driftnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		Campbell Creek		Ship Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/26-6/29/98	1,162	0	0	10	10	66	46	76	47	6.51%	0.40%
07/03/1998	3,360	83	25	36	11	13	12	133	30	3.95%	0.09%
07/06/1998	4,790	111	28	31	9	112	36	254	46	5.29%	0.10%
07/10/1998	23,898	550	69	131	22	286	63	968	96	4.05%	0.04%
07/11/1998	126	0	0	0	0	0	0	0	0	0.00%	0.00%
07/13/1998	187	8	5	0	0	6	6	14	7	7.51%	0.40%
07/15/1998	437	18	8	2	2	7	7	28	11	6.34%	0.24%
07/17/1998	31,134	1,386	116	270	34	733	107	2,388	161	7.67%	0.05%
08/01/1998	498	0	0	0	0	0	0	0	0	0.00%	0.00%
08/02/1998	945	9	8	4	4	0	0	13	9	1.34%	0.09%
08/03/1998	7,949	315	46	67	14	252	53	634	71	7.98%	0.09%
08/05/1998	254	0	0	0	0	0	0	0	0	0.00%	0.00%
08/07/1998	8,597	49	34	0	0	77	54	126	63	1.46%	0.07%
<b>Total<sup>a</sup></b>	83,337	2,528	151	552	46	1,551	157	4,632	223	5.56%	0.03%

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B4.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1997 by release site in Upper Cook Inlet Central District Ninilchik Beach (244-21) setnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/29-7/10/98	18	0	0	0	0	0.00%	0.00
07/11/1998	4	0	0	0	0	0.00%	0.00
07/13/1998	36	0	0	0	0	0.00%	0.00
07/15/1998	125	0	0	0	0	0.00%	0.00
07/17/1998	84	0	0	0	0	0.00%	0.00
07/20/1998	60	0	0	0	0	0.00%	0.00
08/01/1998	656	0	0	0	0	0.00%	0.00
08/02/1998	688	0	0	0	0	0.00%	0.00
08/03/1998	1,013	0	0	0	0	0.00%	0.00
08/05/1998	758	20	19	20	19	2.61%	0.00
08/07/1998	487	0	0	0	0	0.00%	0.00
08/10/1998	498	0	0	0	0	0.00%	0.00
<b>Total<sup>a</sup></b>	4,427	20	19	20	19	0.45%	0.00

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B5.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1997 by release site in Upper Cook Inlet Central District Coho Beach (244-22) setnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		Campbell Creek		Ship Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/29-7/6/98	21	0	0	0	0	21	33	21	33	100.00%	15.78%
07/10/1998	9	0	0	0	0	0	0	0	0	0.00%	0.00%
07/11/1998	11	0	0	0	0	0	0	0	0	0.00%	0.00%
07/13/1998	87	0	0	2	2	0	0	2	2	2.39%	0.17%
07/15/1998	126	0	0	0	0	0	0	0	0	0.00%	0.00%
07/17/1998	112	0	0	0	0	0	0	0	0	0.00%	0.00%
07/20/1998	31	0	0	0	0	0	0	0	0	0.00%	0.00%
08/01/1998	612	0	0	0	0	0	0	0	0	0.00%	0.00%
08/02/1998	726	0	0	0	0	0	0	0	0	0.00%	0.00%
08/03/1998	944	0	0	0	0	0	0	0	0	0.00%	0.00%
08/05/1998	388	0	0	3	3	0	0	3	3	0.88%	0.07%
08/07/1998	314	5	5	0	0	0	0	5	5	1.62%	0.15%
08/10/1998	527	22	21	0	0	0	0	22	21	4.16%	0.41%
<b>Total<sup>a</sup></b>	3,908	27	22	5	3	21	33	54	40	1.37%	0.10%

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B6.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1997 by release site in Upper Cook Inlet Central District Kalifonsky Beach (244-30) setnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		Campbell Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/29-7/10/98	22	0	0	0	0	0	0	0.00%	0.00%
07/11/1998	6	0	0	0	0	0	0	0.00%	0.00%
07/13/1998	102	14	9	0	0	14	9	13.82%	0.90%
07/15/1998	91	0	0	0	0	0	0	0.00%	0.00%
07/17/1998	150	0	0	5	5	5	5	3.51%	0.32%
07/20/1998	20	0	0	0	0	0	0	0.00%	0.00%
08/01/1998	461	0	0	3	2	3	2	0.65%	0.05%
08/02/1998	734	0	0	0	0	0	0	0.00%	0.00%
08/03/1998	623	0	0	0	0	0	0	0.00%	0.00%
08/05/1998	533	0	0	0	0	0	0	0.00%	0.00%
08/07/1998	611	0	0	0	0	0	0	0.00%	0.00%
08/10/1998	992	0	0	0	0	0	0	0.00%	0.00%
<b>Total<sup>a</sup></b>	4,345	14	9	8	5	22	11	0.51%	0.02%

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B7.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1997 by release site in Upper Cook Inlet Central District Salamatof Beach (244-40) setnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		Ship Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/29-7/11/98	90	0	0	0	0	0	0	0.00%	0.00%
7/13-7/15/98	374	20	9	8	7	28	12	7.46%	0.31%
7/17-7/20/98	1,125	40	19	16	15	56	24	4.94%	0.22%
08/01/1998	230	0	0	0	0	0	0	0.00%	0.00%
08/02/1998	986	26	25	80	56	106	62	10.77%	0.62%
08/03/1998	529	5	5	0	0	5	5	1.01%	0.09%
08/05/1998	505	0	0	0	0	0	0	0.00%	0.00%
08/07/1998	503	19	13	15	15	35	20	6.89%	0.39%
08/10/1998	1,640	0	0	13	13	13	13	0.82%	0.08%
<b>Total<sup>a</sup></b>	5,982	111	36	133	62	243	71	4.06%	0.12%

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B8.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1997 by release site in Upper Cook Inlet Northern District westside (247-10, 247-20, 247-30) setnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		Campbell Creek		Ship Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/8-7/13/98	2,970	17	17	0	0	0	0	17	17	0.57%	0.06%
07/17/1998	3,134	18	17	0	0	0	0	18	17	0.56%	0.05%
07/24/1998	3,810	48	11	8	2	11	7	67	13	1.76%	0.03%
08/03/1998	863	13	9	0	0	10	10	23	13	2.72%	0.15%
8/7- 8/10/98	1,544	0	0	0	0	0	0	0	0	0.00%	0.00%
08/14/1998	442	4	3	0	0	12	8	16	8	3.57%	0.19%
8/21-8/24/98	211	0	0	0	0	0	0	0	0	0.00%	0.00%
<b>Total<sup>a</sup></b>	12,974	100	28	8	2	33	14	141	31	1.09%	0.02%

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B9.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1997 by release site in Upper Cook Inlet Northern District Susitna Flats/Point MacKenzie (247-41, 247-42) setnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		Campbell Creek		Ship Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
7/10-7/13/98	479	0	0	0	0	0	0	0	0	0.00%	0.00%
07/17/1998	795	34	9	21	4	75	18	130	20	16.39%	0.25%
07/24/1998	1,161	74	13	43	5	205	29	323	32	27.81%	0.28%
08/03/1998	1,492	120	17	52	6	375	41	546	45	36.62%	0.30%
08/07/1998	527	22	8	5	2	117	24	144	25	27.38%	0.48%
08/10/1998	221	0	0	2	2	65	20	67	20	30.28%	0.91%
8/14-8/24/98	195	9	4	0	0	14	7	22	9	11.40%	0.44%
<b>Total<sup>a</sup></b>	4,870	259	25	124	9	850	62	1,233	68	25.32%	0.14%

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B10.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1997 by release site in Upper Cook Inlet Northern District Fire Island (247-43) setnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		Campbell Creek		Ship Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/26-7/13/98	182	14	14	0	0	23	22	37	26	20.29%	1.43%
07/17/1998	1,361	248	44	60	14	208	52	516	69	37.90%	0.51%
07/24/1998	731	156	19	37	5	104	21	296	29	40.56%	0.39%
08/03/1998	668	161	20	27	4	38	13	226	24	33.89%	0.36%
08/07/1998	681	132	22	42	7	199	35	373	42	54.79%	0.61%
08/10/1998	423	74	13	23	4	122	23	219	27	51.78%	0.63%
08/14/1998	395	56	13	6	2	50	16	112	21	28.37%	0.53%
08/17/1998	245	0	0	0	0	0	0	0	0	0.00%	0.00%
08/21/1998	55	7	4	2	1	0	0	9	5	16.82%	0.85%
08/24/1998	26	0	0	2	1	0	0	2	1	6.32%	0.40%
<b>Total<sup>a</sup></b>	4,767	849	61	199	18	743	76	1,791	99	37.57%	0.21%

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.

**Appendix B11.-Estimates ( $r_{ij}$ ) and standard error (SE) of coho salmon stocked in 1997 by release site in Upper Cook Inlet Northern District eastside (247-70, 247-80, 247-90) setnet commercial harvest, 1998.**

Date	Coho Harvest	Bird Creek		Campbell Creek		Ship Creek		NCI Hatchery Contribution			
		$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	$r_{ij}$	SE	%	SE(%)
6/26-7/13/98	584	27	27	0	0	0	0	27	27	4.64%	0.46%
07/17/1998	1,129	62	21	15	7	24	17	102	27	9.03%	0.24%
07/24/1998	1,331	24	13	12	6	12	12	48	19	3.61%	0.14%
08/03/1998	1,047	102	16	14	3	23	10	139	20	13.32%	0.19%
08/07/1998	618	91	19	12	4	55	20	159	28	25.66%	0.45%
08/10/1998	657	41	11	4	2	12	8	56	13	8.59%	0.20%
08/14/1998	1,785	23	7	0	0	0	0	23	7	1.28%	0.04%
08/17/1998	1,804	18	7	0	0	6	5	24	9	1.34%	0.05%
08/21/1998	956	0	0	0	0	0	0	0	0	0.00%	0.00%
08/24/1998	521	8	5	0	0	6	5	14	7	2.60%	0.14%
08/28/1998	282	0	0	0	0	0	0	0	0	0.00%	0.00%
08/31/1998	38	0	0	0	0	0	0	0	0	0.00%	0.00%
09/04/1998	285	0	0	0	0	0	0	0	0	0.00%	0.00%
09/07/1998	134	0	0	0	0	0	0	0	0	0.00%	0.00%
09/11/1998	29	0	0	0	0	0	0	0	0	0.00%	0.00%
<b>Total<sup>a</sup></b>	11,200	397	47	57	10	138	32	592	57	5.29%	0.05%

<sup>a</sup> Totals may not equal sum of individual estimates due to rounding.